DataProcessing

G12: Yufei Liu, Kathy Zhang, Liujun Hua

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## Data Cleaning and Variable Creation

setwd("~/GitHub/bigdata\_g12/FinalProject")  
  
## Data Cleaning and Variable Creation  
  
# Load the datasets  
popular\_vg <- read.csv("popular\_vg\_1980-2023.csv", stringsAsFactors = FALSE)  
vgchartz\_2024 <- read.csv("vgchartz-2024.csv", stringsAsFactors = FALSE)  
names(vgchartz\_2024)[names(vgchartz\_2024) == "title"] <- "Title"  
  
popular\_vg$Release.Date <- as.Date(popular\_vg$Release.Date, format="%Y-%m-%d")  
popular\_vg$year <- year(popular\_vg$Release.Date)  
popular\_vg <- popular\_vg[order(popular\_vg$year), ]  
  
# Clean two datasets  
popular\_vg <- popular\_vg %>%  
 group\_by(Title) %>%  
 summarise(  
 Release.Date = first(Release.Date),  
 year = first(year),  
 Team = first(Team),  
 Rating = first(Rating),  
 Times.Listed = first(Times.Listed),  
 Number.of.Reviews = first(Number.of.Reviews),  
 Genres = first(Genres),  
 Summary = first(Summary),  
 Reviews = paste(unique(Reviews), collapse = " "),  
 Plays = first(Plays),  
 Playing = first(Playing),  
 Backlogs = first(Backlogs),  
 Wishlist = first(Wishlist),  
 .groups = 'drop'  
 )  
  
vgchartz\_2024 <- vgchartz\_2024 %>%  
 group\_by(Title) %>%  
 summarise(  
 console = paste(unique(console), collapse = " "),  
 publisher = first(publisher),  
 developer = first(developer),  
 genre = first(genre),  
 total\_sales = sum(total\_sales), # Corrected typo here  
 .groups = 'drop'  
 )  
  
# Perform the inner join  
game <- inner\_join(vgchartz\_2024[, c("Title", "console", "publisher", "developer", "genre", "total\_sales")], popular\_vg[, c("Title","Release.Date", "Genres", "Rating", "Times.Listed", "year", "Number.of.Reviews", "Summary", "Reviews", "Plays", "Playing", "Backlogs", "Wishlist")], by = "Title")  
game <- game %>% distinct()  
  
# Convert 'Plays' and 'Number.of.Reviews' from K format to numeric  
game$Plays <- as.numeric(str\_replace(game$Plays, "K", "")) \* 1000  
game$Playing <- as.numeric(str\_replace(game$Playing, "K", "")) \* 1000  
game$Backlogs <- as.numeric(str\_replace(game$Backlogs, "K", "")) \* 1000  
game$Wishlist <- as.numeric(str\_replace(game$Wishlist, "K", "")) \* 1000  
game$Number.of.Reviews <- as.numeric(str\_replace(game$Number.of.Reviews, "K", "")) \* 1000  
  
# Keep only post 2005 data  
game <- game %>% filter(year >= 2005)  
  
# Remove rows with NAs only in the specified columns  
columns\_to\_clean <- c("Rating", "Summary", "Reviews", "year")  
game <- game %>%  
 filter(!if\_any(all\_of(columns\_to\_clean), is.na))  
  
# Create additional vars  
game <- game %>%  
 mutate(atvi\_indi = ifelse(publisher %in% c("Activision", "Blizzard Entertainment") | developer == "Blizzard Entertainment", 1, 0))  
game$activePlayers <- game$Plays + game$Playing  
game$allPlayers <- game$Plays + game$Playing + game$Backlogs   
game$year\_adj <- game$year - 2000  
game$log\_activePlayers <- log(game$activePlayers+1)  
game$log\_allPlayers <- log(game$allPlayers+1)  
game <- game %>%   
 mutate(activePlayers\_dummy = ifelse(allPlayers > median(game$activePlayers), 1, 0))  
  
summary(game)

## Title console publisher developer   
## Length:648 Length:648 Length:648 Length:648   
## Class :character Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character Mode :character   
##   
##   
##   
##   
## genre total\_sales Release.Date Genres   
## Length:648 Min. : 0.020 Min. :2005-01-11 Length:648   
## Class :character 1st Qu.: 0.350 1st Qu.:2010-11-10 Class :character   
## Mode :character Median : 0.585 Median :2015-04-07 Mode :character   
## Mean : 1.873 Mean :2015-02-01   
## 3rd Qu.: 1.775 3rd Qu.:2019-09-05   
## Max. :21.780 Max. :2023-03-17   
## NA's :580   
## Rating Times.Listed year Number.of.Reviews  
## Min. :1.600 Length:648 Min. :2005 Min. : 1000   
## 1st Qu.:3.300 Class :character 1st Qu.:2010 1st Qu.:128500   
## Median :3.700 Mode :character Median :2015 Median :320500   
## Mean :3.633 Mean :2015 Mean :350174   
## 3rd Qu.:4.000 3rd Qu.:2019 3rd Qu.:534250   
## Max. :4.600 Max. :2023 Max. :995000   
##   
## Summary Reviews Plays Playing   
## Length:648 Length:648 Min. : 1000 Min. : 0   
## Class :character Class :character 1st Qu.: 2600 1st Qu.: 35000   
## Mode :character Mode :character Median : 5300 Median : 90000   
## Mean : 62055 Mean :164803   
## 3rd Qu.: 12000 3rd Qu.:206750   
## Max. :992000 Max. :999000   
##   
## Backlogs Wishlist atvi\_indi activePlayers   
## Min. : 1000 Min. : 1000 Min. :0.00000 Min. : 1100   
## 1st Qu.: 1900 1st Qu.: 46500 1st Qu.:0.00000 1st Qu.: 49300   
## Median : 71000 Median :238000 Median :0.00000 Median : 122550   
## Mean :256424 Mean :306262 Mean :0.03241 Mean : 226858   
## 3rd Qu.:492250 3rd Qu.:504250 3rd Qu.:0.00000 3rd Qu.: 309375   
## Max. :999000 Max. :994000 Max. :1.00000 Max. :1224000   
##   
## allPlayers year\_adj log\_activePlayers log\_allPlayers   
## Min. : 8500 Min. : 5.00 Min. : 7.004 Min. : 9.048   
## 1st Qu.: 163075 1st Qu.:10.00 1st Qu.:10.806 1st Qu.:12.002   
## Median : 397900 Median :15.00 Median :11.716 Median :12.894   
## Mean : 483282 Mean :14.54 Mean :11.659 Mean :12.692   
## 3rd Qu.: 736600 3rd Qu.:19.00 3rd Qu.:12.642 3rd Qu.:13.510   
## Max. :2015000 Max. :23.00 Max. :14.018 Max. :14.516   
##   
## activePlayers\_dummy  
## Min. :0.0000   
## 1st Qu.:1.0000   
## Median :1.0000   
## Mean :0.8256   
## 3rd Qu.:1.0000   
## Max. :1.0000   
##

write.csv(game, "game.csv", row.names = FALSE)

game <- read.csv("game.csv", fill = TRUE)

## Clean Summary

## Clean Summary words  
# Define filler words to be removed  
filler\_words <- c("the", "is", "a", "has", "have", "and", "of", "in", "to", "for", "with", "on", "that", "lets","as", "out", "by","from", "this", "be", "an", "v", "or", "so", "you", "are", "can", "will", "which", "t", "who", "where", "also", "his", "her", "their", "they", "up", "he", "she", "its", "it", "includes", "include","your", "you", "all","���������", "s", "any", "ll", "was", "but", "if", "there", "these")  
  
# Function to clean and tokenize text, removing filler words  
clean\_and\_tokenize <- function(text, filler\_words) {  
 text\_clean <- tolower(enc2utf8(text))  
 # text\_clean <- tolower(gsub("[^\\x01-\\x7F]", "", text\_clean))  
 text\_clean <- str\_replace\_all(text\_clean, "[[:punct:]]", " ")  
 words <- unlist(strsplit(text\_clean, "\\s+"))  
 words <- words[!words %in% filler\_words]  
 return(words)  
}  
  
# Apply the function to the Summary column  
game$Summary\_clean <- sapply(game$Summary, function(x) paste(clean\_and\_tokenize(x, filler\_words), collapse = " "))  
  
# Create a corpus from the cleaned summaries  
corpus <- Corpus(VectorSource(game$Summary\_clean))  
tdm <- TermDocumentMatrix(corpus, control = list(wordLengths = c(1, Inf)))  
tdm\_matrix <- as.matrix(tdm)  
  
  
# Get word frequencies  
word\_freq <- sort(rowSums(tdm\_matrix), decreasing = TRUE)  
word\_freq\_df <- data.frame(word = names(word\_freq), frequency = word\_freq)  
  
# Filter for significant words  
sig\_word\_sum <- word\_freq\_df %>% filter(frequency > 5)  
sig\_word\_sum <- sig\_word\_sum %>% arrange(word) %>% slice(-1:-19)  
sig\_word\_sum <- as.character(sig\_word\_sum$word)  
  
# Convert to sparse matrix  
tdm\_filtered <- tdm\_matrix[sig\_word\_sum, ]  
tdm\_sparse <- as(t(tdm\_filtered), "sparseMatrix")  
  
  
# Filter the term-document matrix to keep only significant words  
tdm\_filtered <- tdm\_matrix[sig\_word\_sum, ]  
tdm\_sparse <- as(t(tdm\_filtered), "sparseMatrix")

## Yufei's IP  
game$series <- sapply(str\_split(game$Title, "\\s+"), function(words) {  
 paste(words[1:min(length(words), 2)], collapse = " ")  
})  
  
# 计算每个系列的出现次数  
series\_counts <- game %>%  
 group\_by(series, publisher) %>%  
 summarise(Count = n(), .groups = 'drop')  
  
# 将 series\_counts 加入到原数据框中  
game <- game %>%  
 left\_join(series\_counts, by = c("series", "publisher"))  
  
# 标记大IP和小IP  
game <- game %>%  
 mutate(IP\_Type = case\_when(  
 Count >= 6 ~ "Big IP",  
 Count >= 4 ~ "Medium IP",  
 Count >= 2 ~ "Small IP",  
 TRUE ~ "Not IP"  
 ))  
  
game <- game %>%  
 mutate(activePlayersGroup = cut(activePlayers, breaks = c(-Inf, 120000, 170000, Inf), labels = c("Low", "Medium", "High")))  
  
ip\_data <- game %>%  
 filter(IP\_Type %in% c("Big IP", "Small IP","Medium IP"))  
  
ip\_data$activePlayers <- as.numeric(ip\_data$activePlayers)  
table(ip\_data$IP\_Type)

##   
## Big IP Medium IP Small IP   
## 37 40 94

ip\_data$activePlayers <- as.numeric(ip\_data$activePlayers)  
  
summary(ip\_data$activePlayers)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 3700 48000 102600 176144 214850 995000

ip\_avg\_active\_players <- ip\_data %>%  
 group\_by(IP\_Type) %>%  
 summarise(  
 avg\_activePlayers = mean(activePlayers, na.rm = TRUE),  
 max\_activePlayers = max(activePlayers, na.rm = TRUE),  
 min\_activePlayers = min(activePlayers, na.rm = TRUE),  
 count = n()  
 )  
  
library(glmnet)  
library(caret)  
game <- game %>%  
 filter(!is.na(Rating) & !is.na(genre) & !is.na(IP\_Type))  
game$IP\_Type <- factor(game$IP\_Type, levels = c("Big IP", "Medium IP", "Small IP", "Not IP"))

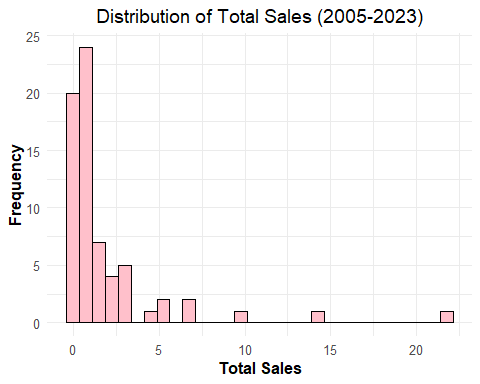
## Processing Console  
  
consoles\_list <- strsplit(game$console, split = " ")  
unique\_consoles <- unique(unlist(consoles\_list))  
console\_matrix <- matrix(0, nrow = nrow(game), ncol = length(unique\_consoles), dimnames = list(NULL, unique\_consoles))  
for (i in seq\_along(consoles\_list)) {  
 console\_matrix[i, consoles\_list[[i]]] <- 1  
}  
console\_sparse <- Matrix(console\_matrix, sparse = TRUE)  
console\_df <- as.data.frame(as.matrix(console\_sparse))  
colnames(console\_df) <- unique\_consoles

## Combine x   
  
set.seed(1234)  
  
genre\_dummies <- model.matrix(~ genre - 1, data = game)  
year\_cont <- model.matrix(~ year\_adj, data = game)  
publisher\_dummies <- model.matrix(~ publisher - 1, data = game)  
game$Rating <- as.numeric(game$Rating)  
rating\_cont <- model.matrix(~ Rating, data = game)  
ip\_dummies <- model.matrix(~ IP\_Type - 1, data = game)  
x <- cbind(genre\_dummies, year\_cont, publisher\_dummies, rating\_cont, ip\_dummies, tdm\_sparse, console\_sparse)  
x <- as(x, "sparseMatrix")  
  
# Make into a df for 3.B(2)(3) trees and forest  
x\_tree <- cbind(game[, c("year\_adj", "publisher", "genre", "IP\_Type", "Rating")], console\_df)  
  
y <- game$log\_activePlayers

## Explore potential Y variables

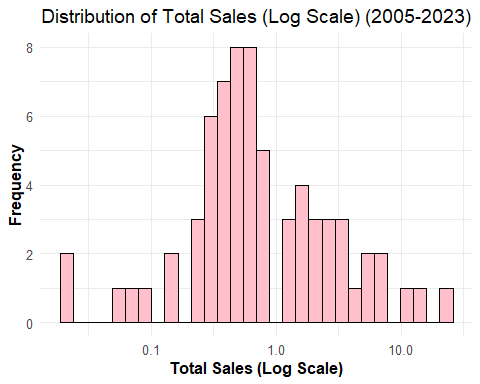
# Plot the distribution of total\_sales and plays  
ggplot(game, aes(x = total\_sales)) +   
 geom\_histogram(bins = 30, fill = "pink", color = "black") +  
 theme\_minimal() +  
 labs(title = "Distribution of Total Sales (2005-2023)", x = "Total Sales", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))

## Warning: Removed 580 rows containing non-finite outside the scale range  
## (`stat\_bin()`).

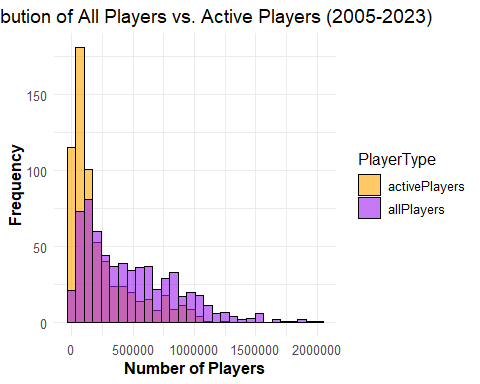


ggplot(game, aes(x = total\_sales)) +   
 geom\_histogram(bins = 30, fill = "pink", color = "black") +  
 theme\_minimal() +  
 scale\_x\_log10() +  
 labs(title = "Distribution of Total Sales (Log Scale) (2005-2023)", x = "Total Sales (Log Scale)", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))

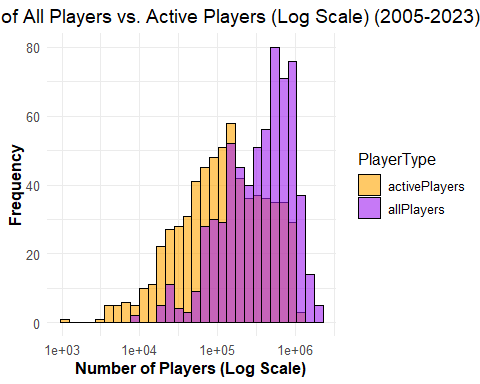
## Warning: Removed 580 rows containing non-finite outside the scale range  
## (`stat\_bin()`).



# Reshaping the data to long format  
game\_long <- game %>%  
 # select(allPlayers, activePlayers) %>% # Select the necessary columns  
 pivot\_longer(  
 cols = c(allPlayers, activePlayers),  
 names\_to = "PlayerType",  
 values\_to = "Players"  
 )   
  
ggplot(game\_long, aes(x = Players, fill = PlayerType)) +  
 geom\_histogram(bins = 30, alpha = 0.6, position = "identity", color = "black") +  
 scale\_fill\_manual(values = c("orange", "purple")) +  
 labs(title = "Distribution of All Players vs. Active Players (2005-2023)",  
 x = "Number of Players",  
 y = "Frequency") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))

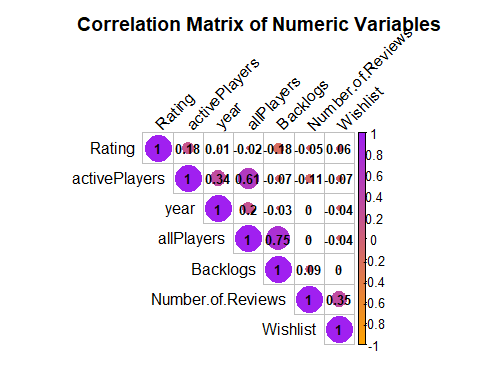


ggplot(game\_long, aes(x = Players, fill = PlayerType)) +  
 geom\_histogram(bins = 30, alpha = 0.6, position = "identity", color = "black") +  
 scale\_x\_log10() +   
 scale\_fill\_manual(values = c("orange", "purple")) +  
 labs(title = "Distribution of All Players vs. Active Players (Log Scale) (2005-2023)",  
 x = "Number of Players (Log Scale)",  
 y = "Frequency") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))

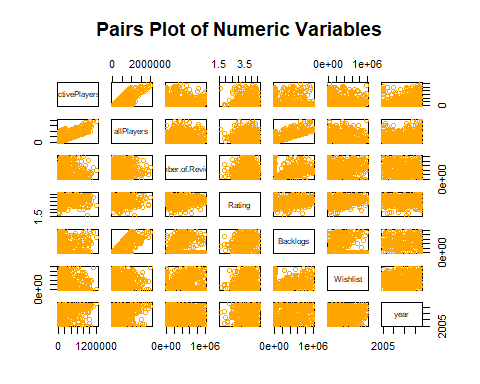


## EDA

col\_purple\_orange <- colorRampPalette(c("orange","purple"))  
# Plot the correlation matrix with correlation coefficients  
numeric\_vars <- game[, c("activePlayers", "allPlayers", "Number.of.Reviews", "Rating", "Backlogs", "Wishlist", "year")]  
cor\_matrix <- cor(numeric\_vars)  
corrplot(cor\_matrix, method = "circle", col = col\_purple\_orange(200),  
 type = "upper", order = "hclust", tl.col = "black", tl.srt = 45,  
 addCoef.col = "black", cl.cex = 0.8, number.cex = 0.8)  
title("Correlation Matrix of Numeric Variables", line = 2.5, cex.main = 1.2)



pairs(numeric\_vars, col = "orange", main = "Pairs Plot of Numeric Variables")

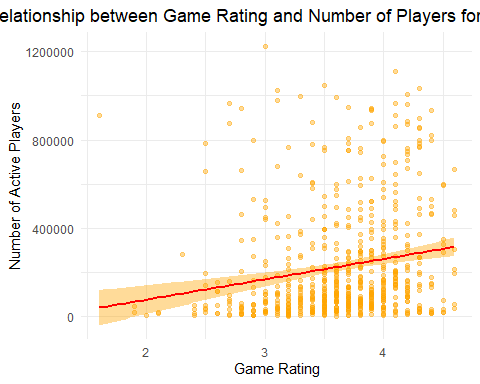


cor\_matrix

## activePlayers allPlayers Number.of.Reviews Rating  
## activePlayers 1.00000000 0.608729668 -0.113887930 0.18445853  
## allPlayers 0.60872967 1.000000000 -0.004954418 -0.01984942  
## Number.of.Reviews -0.11388793 -0.004954418 1.000000000 -0.05016626  
## Rating 0.18445853 -0.019849424 -0.050166264 1.00000000  
## Backlogs -0.06767694 0.750361763 0.088658885 -0.17864890  
## Wishlist -0.06560575 -0.041325219 0.345962458 0.05847168  
## year 0.33535884 0.201225221 -0.004566309 0.01196529  
## Backlogs Wishlist year  
## activePlayers -0.067676940 -0.065605754 0.335358841  
## allPlayers 0.750361763 -0.041325219 0.201225221  
## Number.of.Reviews 0.088658885 0.345962458 -0.004566309  
## Rating -0.178648902 0.058471680 0.011965287  
## Backlogs 1.000000000 0.002693206 -0.026365140  
## Wishlist 0.002693206 1.000000000 -0.044853688  
## year -0.026365140 -0.044853688 1.000000000

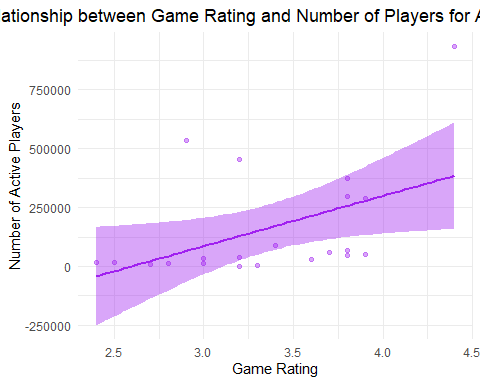
library(ggplot2)  
library(dplyr)  
  
# Plot for all games  
p1 <- ggplot(game, aes(x = Rating, y = activePlayers)) +  
 geom\_point(alpha = 0.4, color = "orange") +  
 geom\_smooth(method = "lm", color = "red", fill = "orange", se = TRUE) +  
 labs(title = "Relationship between Game Rating and Number of Players for All Games",  
 x = "Game Rating", y = "Number of Active Players") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5))  
p1

## `geom\_smooth()` using formula = 'y ~ x'



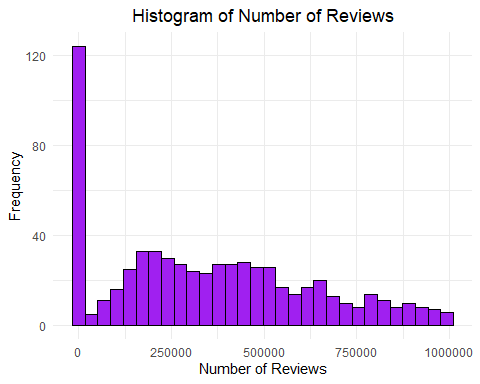
# Plot for Activision Blizzard games  
p2 <- ggplot(game %>% filter(atvi\_indi == 1), aes(x = Rating, y = activePlayers)) +  
 geom\_point(alpha = 0.4, color = "purple") +  
 geom\_smooth(method = "lm", color = "purple", fill = "purple", se = TRUE) +  
 labs(title = "Relationship between Game Rating and Number of Players for ATVI Games",  
 x = "Game Rating", y = "Number of Active Players") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5))  
p2

## `geom\_smooth()` using formula = 'y ~ x'

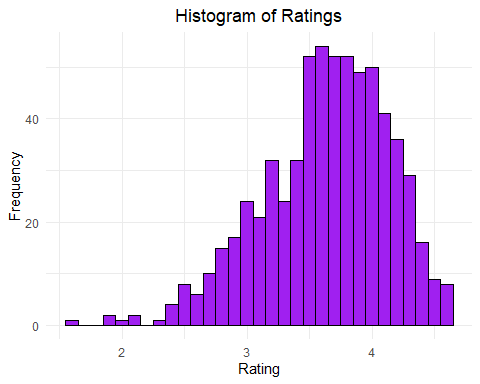


# Plot histograms  
p1 <- ggplot(game, aes(x = Number.of.Reviews)) +  
 geom\_histogram(fill = "purple", color = "black") +  
 theme\_minimal() +  
 labs(title = "Histogram of Number of Reviews", x = "Number of Reviews", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
p2 <- ggplot(game, aes(x = Rating)) +  
 geom\_histogram(binwidth = 0.1, fill = "purple", color = "black") +  
 theme\_minimal() +  
 labs(title = "Histogram of Ratings", x = "Rating", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
p3 <- ggplot(game, aes(x = Wishlist)) +  
 geom\_histogram(fill = "purple", color = "black") +  
 theme\_minimal() +  
 labs(title = "Histogram of Wishlists", x = "Number of Wishlists", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
# Plot average per year  
avg\_reviews\_per\_year <- ggplot(game, aes(x = year, y = Number.of.Reviews)) +  
 stat\_summary(fun = mean, geom = "bar", fill = "orange", color = "black") +  
 theme\_minimal() +  
 labs(title = "Average Number of Reviews per Year", x = "Year", y = "Average Number of Reviews") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
avg\_rating\_per\_year <- ggplot(game, aes(x = year, y = Rating)) +  
 stat\_summary(fun = mean, geom = "bar", fill = "orange", color = "black") +  
 theme\_minimal() +  
 labs(title = "Average Rating per Year", x = "Year", y = "Average Rating") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
avg\_wishlists\_per\_year <- ggplot(game, aes(x = year, y = Wishlist)) +  
 stat\_summary(fun = mean, geom = "bar", fill = "orange", color = "black") +  
 theme\_minimal() +  
 labs(title = "Average Number of Wishlists per Year", x = "Year", y = "Average Number of Wishlists") +  
 theme(plot.title = element\_text(hjust = 0.5))  
  
p1

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.

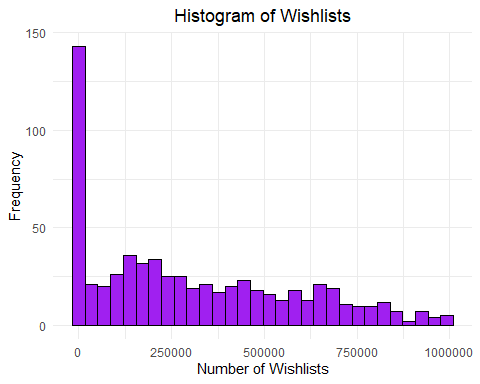


p2

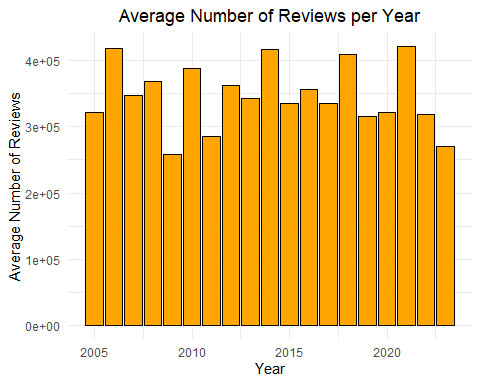


p3

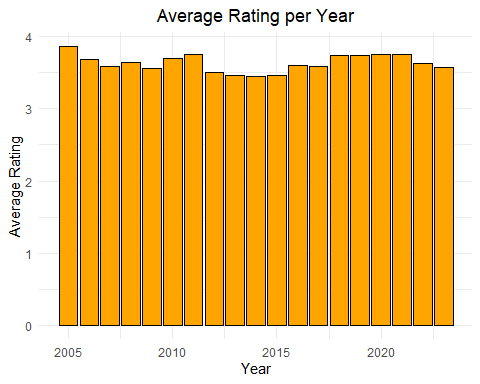
## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.



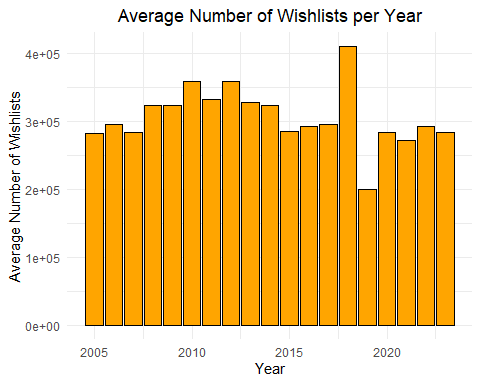
avg\_reviews\_per\_year



avg\_rating\_per\_year



avg\_wishlists\_per\_year



# Plot relationship between total sales and players  
p <- ggplot() +  
 geom\_point(data = game, aes(x = activePlayers, y = total\_sales, color = "Active Players")) +  
 geom\_smooth(data = game, aes(x = activePlayers, y = total\_sales, color = "Active Players"), method = "lm", fill = "orange") +  
 geom\_point(data = game, aes(x = allPlayers, y = total\_sales, color = "All Players")) +  
 geom\_smooth(data = game, aes(x = allPlayers, y = total\_sales, color = "All Players"), method = "lm", fill = "pink") +  
 labs(title = "Total Sales vs Players (2005-2023)",  
 x = "Players",  
 y = "Total Sales",  
 color = "Player Type") + # Label for the legend  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold")) +  
 scale\_x\_continuous(limits = c(0, 1000000)) +  
 scale\_color\_manual(values = c("Active Players" = "orange", "All Players" = "purple"))  
  
p

## `geom\_smooth()` using formula = 'y ~ x'

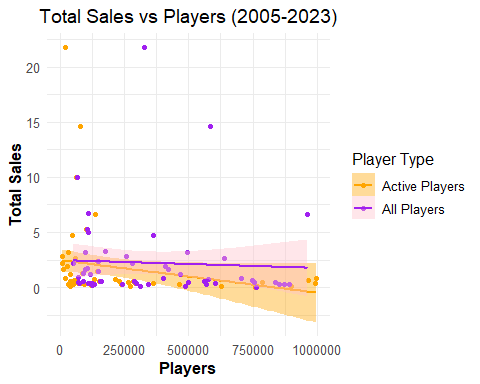
## Warning: Removed 580 rows containing non-finite outside the scale range  
## (`stat\_smooth()`).

## `geom\_smooth()` using formula = 'y ~ x'

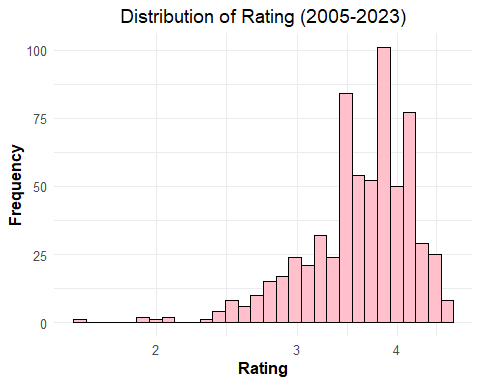
## Warning: Removed 593 rows containing non-finite outside the scale range  
## (`stat\_smooth()`).

## Warning: Removed 580 rows containing missing values or values outside the scale range  
## (`geom\_point()`).

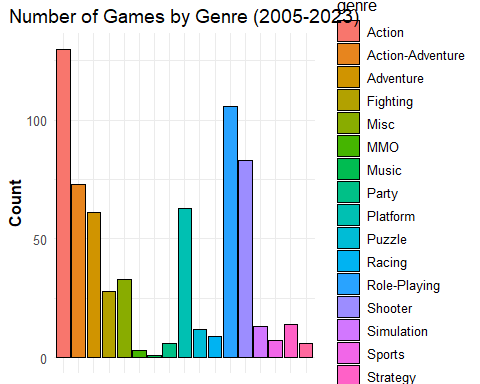
## Warning: Removed 593 rows containing missing values or values outside the scale range  
## (`geom\_point()`).



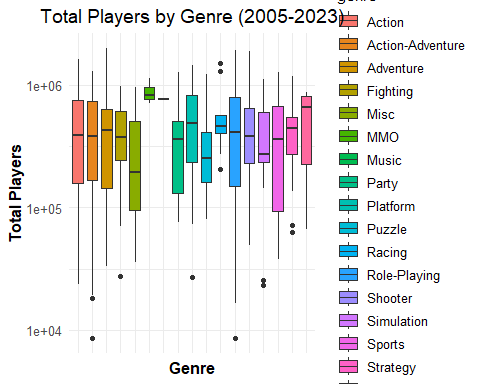
ggplot(game, aes(x = Rating)) +   
 geom\_histogram(bins = 30, fill = "pink", color = "black") +  
 theme\_minimal() +  
 scale\_x\_log10() +  
 labs(title = "Distribution of Rating (2005-2023)", x = "Rating", y = "Frequency") +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))



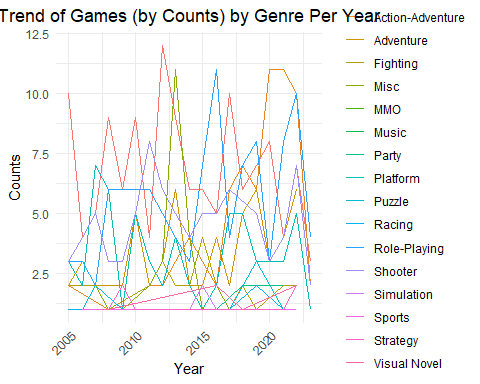
# Games by Genre  
ggplot(game, aes(x = genre, fill = genre)) +  
 geom\_bar(color = "black") +  
 labs(title = "Number of Games by Genre (2005-2023)",  
 x = "", # Remove x-axis label  
 y = "Count") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"),  
 legend.title = element\_text(),  
 axis.text.x = element\_blank(),  
 axis.ticks.x = element\_blank(),  
 axis.title.x = element\_blank())



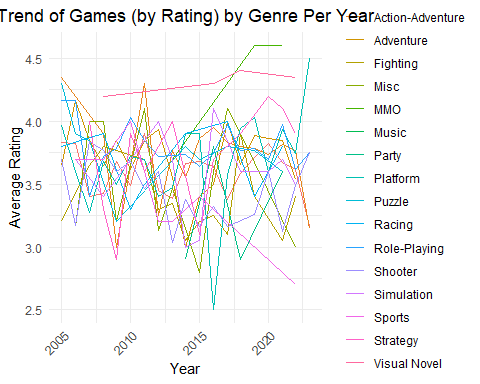
ggplot(game, aes(x = genre, y = allPlayers, fill = genre)) +  
 geom\_boxplot() +  
 scale\_y\_log10() + # Log scale for the y-axis to handle wide data range  
 labs(title = "Total Players by Genre (2005-2023)",  
 x = "Genre",  
 y = "Total Players") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"),  
 legend.title = element\_text(),  
 axis.text.x = element\_blank())



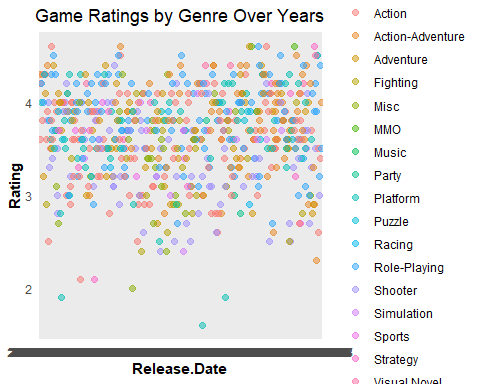
# Prepare the data: count games per year per genre  
game\_year\_genre <- game %>%  
 group\_by(year, genre) %>%  
 summarise(count = n(), .groups = 'drop') # ensure you have year and genre as factors or appropriate format  
  
# Plotting  
ggplot(game\_year\_genre, aes(x = year, y = count, color = genre, group = genre)) +  
 geom\_line() +  
 labs(title = "Trend of Games (by Counts) by Genre Per Year", x = "Year", y = "Counts") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.text.x = element\_text(angle = 45, hjust = 1), # Rotate x-axis labels for better visibility  
 legend.title = element\_blank())



game\_year\_genre <- game %>%  
 group\_by(year, genre) %>%  
 summarise(Average\_Rating = mean(Rating, na.rm = TRUE), .groups = 'drop')   
ggplot(game\_year\_genre, aes(x = year, y = Average\_Rating, color = genre, group = genre)) +  
 geom\_line() +  
 labs(title = "Trend of Games (by Rating) by Genre Per Year",  
 x = "Year",  
 y = "Average Rating") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.text.x = element\_text(angle = 45, hjust = 1),  
 legend.title = element\_blank())

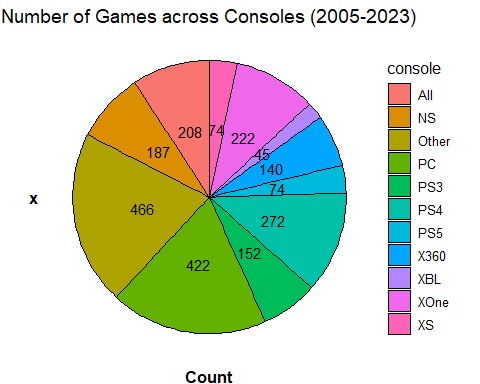


ggplot(game, aes(x = Release.Date, y = Rating, color = genre)) + #Release.Date  
 geom\_point(alpha = 0.5, size = 2) +  
 labs(title = "Game Ratings by Genre Over Years",  
 x = "Release.Date",  
 y = "Rating") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.title = element\_text(face = "bold"),  
 legend.title = element\_text(face = "bold")) +  
 guides(color = guide\_legend(title = "Genre"))

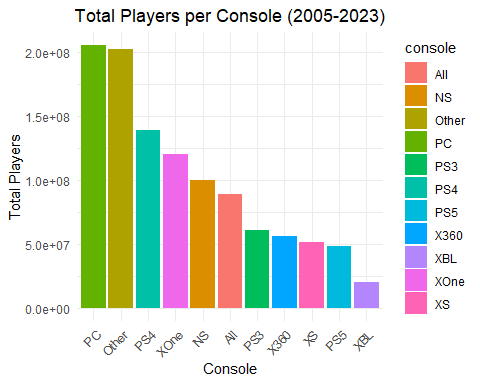


# Distribution of games by console in the subset data  
game\_long <- game %>%  
 tidyr::separate\_rows(console, sep = " ") %>%  
 filter(!is.na(console)) # Ensure console is not NA  
  
console\_counts <- game\_long %>%  
 group\_by(console) %>%  
 summarise(Count = n(),  
 Total\_activePlayers = sum(as.numeric(activePlayers), na.rm = TRUE),  
 Total\_Players = sum(as.numeric(allPlayers), na.rm = TRUE),  
 Average\_Rating = mean(as.numeric(Rating), na.rm = TRUE)) %>%  
 ungroup()  
  
top\_consoles <- console\_counts %>%  
 top\_n(10, Count) %>%  
 arrange(desc(Count))  
other <- console\_counts %>%  
 filter(!console %in% top\_consoles$console) %>%  
 summarise(console = "Other",  
 Count = sum(Count),  
 Total\_activePlayers = sum(Total\_activePlayers),  
 Total\_Players = sum(Total\_Players),  
 Average\_Rating = mean(Average\_Rating))  
final\_console\_data <- bind\_rows(top\_consoles, other)

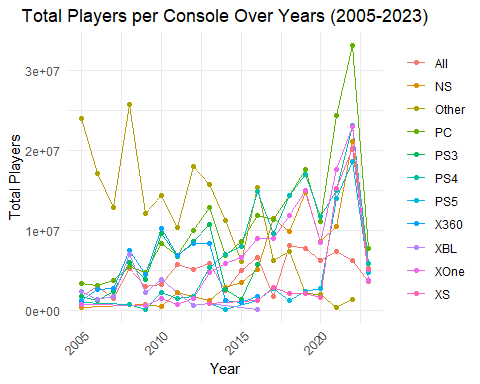
# Pie chart  
pie\_data <- final\_console\_data %>%  
 mutate(label = scales::percent(Count / sum(Count)))  
  
ggplot(pie\_data, aes(x = "", y = Count, fill = console)) +  
 geom\_col(color = "black") +  
 geom\_text(aes(label = Count),  
 position = position\_stack(vjust = 0.5)) +  
 labs(title = "Number of Games across Consoles (2005-2023)") +  
 theme\_void() +  
 coord\_polar(theta = "y") +  
 theme(plot.title = element\_text(hjust = 0.5),  
 text = element\_text(size = 12),  
 axis.title = element\_text(size = 12, face = "bold"))



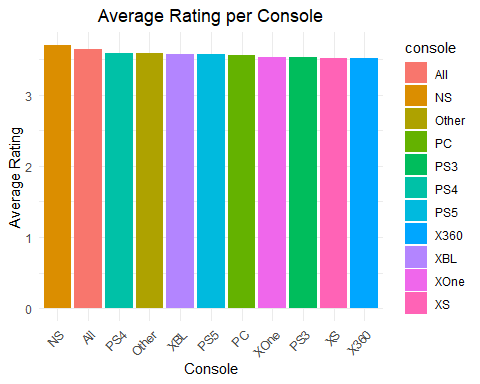
ggplot(final\_console\_data, aes(x = reorder(console, Total\_Players, decreasing = TRUE), y = Total\_Players, fill = console)) +  
 geom\_bar(stat = "identity") +  
 labs(title = "Total Players per Console (2005-2023)", x = "Console", y = "Total Players") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.text.x = element\_text(angle = 45, hjust = 1))



game\_long <- game %>%  
 separate\_rows(console, sep = " ") %>%  
 mutate(allPlayers = as.numeric(allPlayers),  
 year = as.numeric(year)) %>%  
 filter(!is.na(console) & !is.na(allPlayers))  
  
# Summarize data by console and year, considering only top consoles and others  
yearly\_console\_data <- game\_long %>%  
 group\_by(year, console) %>%  
 summarise(Total\_Players = sum(allPlayers, na.rm = TRUE), .groups = 'drop')  
  
# Incorporating top 10 consoles logic and "Other"  
top\_consoles\_list <- top\_consoles$console # Extract just the console names from the previous aggregation  
  
yearly\_console\_data <- yearly\_console\_data %>%  
 mutate(Grouped\_Console = if\_else(console %in% top\_consoles\_list, as.character(console), "Other")) %>%  
 group\_by(year, Grouped\_Console) %>%  
 summarise(Total\_Players = sum(Total\_Players), .groups = 'drop') %>%  
 ungroup()  
  
ggplot(yearly\_console\_data, aes(x = year, y = Total\_Players, group = Grouped\_Console, color = Grouped\_Console)) +  
 geom\_line() +  
 geom\_point() +  
 labs(title = "Total Players per Console Over Years (2005-2023)",  
 x = "Year",  
 y = "Total Players",  
 color = "Console") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.text.x = element\_text(angle = 45, hjust = 1),  
 legend.title = element\_blank())



ggplot(final\_console\_data, aes(x = reorder(console, Average\_Rating, decreasing = TRUE), y = Average\_Rating, fill = console)) +  
 geom\_bar(stat = "identity") +  
 labs(title = "Average Rating per Console", x = "Console", y = "Average Rating") +  
 theme\_minimal() +  
 theme(plot.title = element\_text(hjust = 0.5),  
 axis.text.x = element\_text(angle = 45, hjust = 1))



## Plot word cloud  
  
library(tm)  
library(wordcloud)  
library(dplyr)  
library(RColorBrewer)  
  
# Filter the term-document matrix to keep only significant words  
tdm\_filtered <- tdm\_matrix[sig\_word\_sum, ]  
  
# Create the word cloud  
word\_freq\_filtered <- sort(rowSums(tdm\_filtered), decreasing = TRUE)  
wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, min.freq = 1, scale = c(4, 0.5), colors = brewer.pal(8, "Dark2"))

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## developed could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## gameplay could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## everything could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : may  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## evolved could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## previous could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## quick could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## inhabitants could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## challenge could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## dead could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## future could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## galaxy could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## choices could not be fit on page. It will not be plotted.

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## additional could not be fit on page. It will not be plotted.

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## combine could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## much could not be fit on page. It will not be plotted.

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## possibilities could not be fit on page. It will not be plotted.

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## fast could not be fit on page. It will not be plotted.

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## legendary could not be fit on page. It will not be plotted.

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## platforms could not be fit on page. It will not be plotted.

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## fortune could not be fit on page. It will not be plotted.

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## sisters could not be fit on page. It will not be plotted.

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## dark could not be fit on page. It will not be plotted.

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## around could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## gamers could not be fit on page. It will not be plotted.

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## having could not be fit on page. It will not be plotted.

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## variety could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## each could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : one  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## behind could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## find could not be fit on page. It will not be plotted.

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## remake could not be fit on page. It will not be plotted.

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## phantom could not be fit on page. It will not be plotted.

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## uncover could not be fit on page. It will not be plotted.

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## customization could not be fit on page. It will not be plotted.

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## upgrade could not be fit on page. It will not be plotted.

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## early could not be fit on page. It will not be plotted.

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## treasure could not be fit on page. It will not be plotted.

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## next could not be fit on page. It will not be plotted.

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## forest could not be fit on page. It will not be plotted.

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## challenging could not be fit on page. It will not be plotted.

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## genre could not be fit on page. It will not be plotted.

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## gives could not be fit on page. It will not be plotted.

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## space could not be fit on page. It will not be plotted.

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## bandicoot could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## narrative could not be fit on page. It will not be plotted.

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## embarks could not be fit on page. It will not be plotted.

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## finally could not be fit on page. It will not be plotted.

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## moments could not be fit on page. It will not be plotted.

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## revenge could not be fit on page. It will not be plotted.

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## view could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## influence could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## wright could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## spaces could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## support could not be fit on page. It will not be plotted.

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## shape could not be fit on page. It will not be plotted.

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## dialogue could not be fit on page. It will not be plotted.

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## hand could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## epic could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## change could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## welcome could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## emblem could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## rich could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## post could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## monsters could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## underwater could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## complete could not be fit on page. It will not be plotted.

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## movies could not be fit on page. It will not be plotted.

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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## horror could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## yourself could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## ones could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## favorite could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## tensei could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## track could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : at  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : dlc  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## strategy could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## although could not be fit on page. It will not be plotted.

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## rendered could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## installments could not be fit on page. It will not be plotted.

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## could not be fit on page. It will not be plotted.

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## ability could not be fit on page. It will not be plotted.

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## either could not be fit on page. It will not be plotted.

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## army could not be fit on page. It will not be plotted.

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## signature could not be fit on page. It will not be plotted.

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## dimension could not be fit on page. It will not be plotted.

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## boots could not be fit on page. It will not be plotted.

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## paced could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## techniques could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## spectacular could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## shadows could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## design could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## saga could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## game could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## board could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## second could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## warriors could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : end  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## unlockable could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## creators could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : wii  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## unleash could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## fully could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
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## uncharted could not be fit on page. It will not be plotted.

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## arkham could not be fit on page. It will not be plotted.

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## xbox could not be fit on page. It will not be plotted.

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## gamecube could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## girl could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## cast could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## after could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## sword could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## since could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## creative could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : run  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, : yet  
## could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## wrong could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## advance could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## monster could not be fit on page. It will not be plotted.

## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## playable could not be fit on page. It will not be plotted.

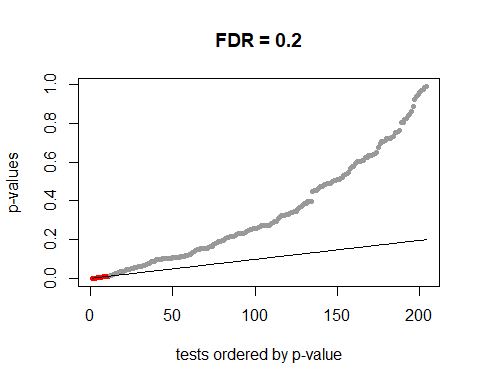
## Warning in wordcloud(names(word\_freq\_filtered), freq = word\_freq\_filtered, :  
## paper could not be fit on page. It will not be plotted.



## FDR

# Selecting columns and creating model matrix  
publisher\_dummies <- model.matrix(~ publisher - 1, data = game)  
developer\_dummies <- model.matrix(~ developer - 1, data = game)  
genre\_dummies <- model.matrix(~ genre - 1, data = game)  
nReviews <- model.matrix(~ Number.of.Reviews, data = game)  
nRating <- model.matrix(~ Rating, data = game)  
wishlist\_dummies <- model.matrix(~ Wishlist, data = game)  
year\_cont <- model.matrix(~ year\_adj, data = game)  
predictors\_fdr <- cbind(year\_cont, genre\_dummies, publisher\_dummies, wishlist\_dummies, developer\_dummies, nReviews, nRating)  
predictors\_fdr <- as(predictors\_fdr, "sparseMatrix")  
predictors\_fdr <- as.data.frame(as.matrix(predictors\_fdr))

# Load necessary library  
library(glmnet)  
library(gamlr)  
library(parallel)  
library(Matrix)  
source("fdr.R")  
  
  
# Split the console column by spaces (or your actual delimiter)  
consoles\_list <- strsplit(game$console, split = " ")  
  
# Flatten the list into a single vector and get unique console types  
unique\_consoles <- unique(unlist(consoles\_list))  
  
# Create a matrix where each row corresponds to a game and each column to a console, filled initially with 0s  
console\_matrix <- matrix(0, nrow = nrow(game), ncol = length(unique\_consoles), dimnames = list(NULL, unique\_consoles))  
for (i in seq\_along(consoles\_list)) {  
 console\_matrix[i, consoles\_list[[i]]] <- 1  
}  
console\_sparse <- Matrix(console\_matrix, sparse = TRUE)  
console\_df <- as.data.frame(as.matrix(console\_sparse))  
colnames(console\_df) <- unique\_consoles  
  
  
# Fit the linear model  
game\_console <- cbind(game[, c("log\_activePlayers", "year\_adj", "Number.of.Reviews", "publisher", "genre", "Rating")], console\_df)  
game\_console$year\_adj <- scale(game\_console$year\_adj)  
game\_console$Rating <- scale(game\_console$Rating)  
game\_console$Number\_of\_Reviews <- scale(game\_console$Number.of.Reviews)  
  
# game\_console$Wishlist <- scale(game\_console$Wishlist)  
  
fit <- lm(log\_activePlayers ~ ., data=game\_console)  
summary\_fit <- summary(fit)  
coefficients <- summary\_fit$coefficients  
mrgpvals <- coefficients[, 4]  
source("fdr.R")  
cutoff <- fdr\_cut(mrgpvals,0.2,TRUE)



significant\_indices <- mrgpvals <= cutoff  
significant\_coefficients <- coefficients[significant\_indices, ]  
significant\_predictors <- rownames(coefficients)[significant\_indices]  
  
significant\_predictors

## [1] "(Intercept)" "year\_adj"   
## [3] "publisherCD Projekt Red Studio" "publisherEA Sports"   
## [5] "publisherMatt Makes Games Inc." "publisherMedia.Vision"   
## [7] "publisherTeam Cherry" "genreMisc"   
## [9] "genrePlatform" "Rating"   
## [11] "PS4"

kable(table(mrgpvals<cutoff))

| Var1 | Freq |
| --- | --- |
| FALSE | 194 |
| TRUE | 10 |

cutoff

## [1] 0.00931286

## LASSO

# Selecting columns and creating model matrix  
game\_console <- cbind(game[, c("year\_adj", "Number.of.Reviews", "publisher", "genre", "Rating")], console\_df)  
game\_console$year\_adj <- scale(game\_console$year\_adj)  
game\_console$Number\_of\_Reviews <- scale(game\_console$Number.of.Reviews)  
game\_console$Rating <- as.numeric(game\_console$Rating)  
  
# Convert to a model matrix for Lasso  
x <- model.matrix(~ ., data = game\_console)

library(gamlr)  
lasso3.cv <- cv.gamlr(x, game$log\_activePlayers, lambda.min.ratio = 1e-3,  
 family = "gaussian", verb = TRUE)

## fold 1,2,3,4,5,done.

# par(mfrow=c(1,2))  
# plot(lasso3.cv$gamlr)  
# plot(lasso3.cv)  
sum(coef(lasso3.cv)!=0) # 1se

## [1] 7

sum(coef(lasso3.cv, s="min")!=0) # min

## [1] 38

sum(coef(lasso3.cv$gamlr)!=0) # AICc

## [1] 42

set.seed(1234)  
# CROSS-VALIDATION  
coef(lasso3.cv) ## 1se rule; see ?cv.gamlr

## 213 x 1 sparse Matrix of class "dgCMatrix"  
## seg17  
## intercept 10.26533584  
## (Intercept) .   
## year\_adj 0.29430633  
## Number.of.Reviews .   
## publisher2K Games .   
## publisher3909 LLC .   
## publisher505 Games .   
## publisher5pb .   
## publisher8-4 .   
## publisherActivision .   
## publisherAksys Games .   
## publisherAmanita Design .   
## publisherAnnapurna Interactive .   
## publisherArc System Works .   
## publisherArena Entertainment .   
## publisherAtari .   
## publisherAtlus .   
## publisherBandai Namco Entertainment .   
## publisherBedtime Digital Games .   
## publisherBerserk Games .   
## publisherBethesda Softworks .   
## publisherBinary Haze Interactive .   
## publisherBlizzard Entertainment .   
## publisherCapcom .   
## publisherCD Projekt .   
## publisherCD Projekt Red Studio .   
## publisherCoffee Stain Publishing .   
## publisherCoffee Stain Studios .   
## publisherDECK13 Interactive GmbH .   
## publisherDeep Silver .   
## publisherDelightworks .   
## publisherDevolver Digital .   
## publisherDotEmu .   
## publisherDouble Fine Presents .   
## publisherDouble Fine Productions .   
## publisherDrinkBox Studios .   
## publisherEA Sports .   
## publisherEidos Interactive .   
## publisherElectronic Arts .   
## publisherEmber Lab .   
## publisherEndnight Games Ltd .   
## publisherFacepalm Games .   
## publisherFinji .   
## publisherFocus Home Interactive .   
## publisherFrictional Games .   
## publisherFuncom .   
## publisherGalactic Cafe .   
## publisherGameMill Entertainment .   
## publisherGearbox Software .   
## publisherGears for Breakfast .   
## publisherGR3 Project .   
## publisherGrinding Gear Games .   
## publisherGT Interactive .   
## publisherGun Media .   
## publisherHi-Rez Studios .   
## publisherHumble Bundle .   
## publisherIgnition Entertainment .   
## publisherInti Creates .   
## publisherIO Interactive .   
## publisherJackbox Games .   
## publisherJumpship .   
## publisherJupiter Corporation .   
## publisherKitfox Games .   
## publisherKonami .   
## publisherKonami Digital Entertainment .   
## publisherLevel 5 .   
## publisherLucasArts .   
## publisherMajesco .   
## publisherMarvelous .   
## publisherMatt Makes Games Inc. .   
## publisherMedia.Vision .   
## publisherMerge Games .   
## publisherMicrosoft Game Studios .   
## publisherMicrosoft Studios .   
## publishermiHoYo .   
## publisherMTV Games .   
## publisherNamco .   
## publisherNamco Bandai .   
## publisherNamco Bandai Games .   
## publisherNdemic Creations .   
## publisherNicalis .   
## publisherNight School Studio .   
## publisherNintendo .   
## publisherNIS America .   
## publisherNumber None .   
## publisherPanic .   
## publisherParadox Interactive .   
## publisherPerfect World Entertainment .   
## publisherPillow Castle .   
## publisherPlaydead .   
## publisherPlaystack .   
## publisherPlayStation PC .   
## publisherPolytron .   
## publisherPopCap Games .   
## publisherPrivate Division .   
## publisherRaw Fury .   
## publisherRebellion Developments .   
## publisherRebellion Games .   
## publisherRed Barrels .   
## publisherRed Hook Studios .   
## publisherRedOctane .   
## publisherRiot Games .   
## publisherRockstar Games .   
## publisherScott Cawthon .   
## publisherSega .   
## publisherSierra Entertainment .   
## publisherSloclap .   
## publisherSold Out .   
## publisherSony Computer Entertainment .   
## publisherSony Computer Entertainment America .   
## publisherSony Interactive Entertainment .   
## publisherSony Online Entertainment .   
## publisherSpike .   
## publisherSpike Chunsoft .   
## publisherSpike Co. .   
## publisherSquare-Enix .   
## publisherSquare Enix .   
## publisherStarbreeze Studios .   
## publisherSteel Crate Games .   
## publisherStudio MDHR .   
## publisherSubset Games .   
## publisherSupergiant Games .   
## publisherTake-Two Interactive .   
## publisherTeam 17 .   
## publisherTeam Cherry .   
## publisherTeam Meat .   
## publisherTecmo .   
## publisherTelltale Games .   
## publisherThe Behemoth .   
## publisherThe Indie Stone .   
## publisherThekla, Inc. .   
## publisherTHQ .   
## publisherThunder Lotus Games .   
## publisherTripwire Interactive .   
## publisherType-Moon .   
## publisherUbisoft .   
## publisherUnknown .   
## publisherValve .   
## publisherValve Corporation .   
## publisherVivendi Games .   
## publisherWarner Bros. Interactive .   
## publisherWarner Bros. Interactive Entertainment .   
## publisherWayForward .   
## publisherWayForward Technologies .   
## publisherWSS playground .   
## publisherWube Software LTD. .   
## publisherXbox Game Studios .   
## publisherXseed Games .   
## publisherYacht Club Games .   
## publisherYoung Horses .   
## publisherZA/UM .   
## genreAction-Adventure .   
## genreAdventure .   
## genreFighting -0.01712225  
## genreMisc -0.04561207  
## genreMMO .   
## genreMusic .   
## genreParty .   
## genrePlatform .   
## genrePuzzle .   
## genreRacing .   
## genreRole-Playing .   
## genreShooter .   
## genreSimulation .   
## genreSports .   
## genreStrategy .   
## genreVisual Novel .   
## Rating 0.37761097  
## All .   
## PS4 0.04139997  
## NS .   
## PC .   
## OSX .   
## XOne .   
## PS5 .   
## XS 0.06300609  
## Series .   
## X360 .   
## XBL .   
## PS3 .   
## Wii .   
## `3DS` .   
## PSV .   
## PS2 .   
## PSN .   
## WiiU .   
## Linux .   
## XB .   
## And .   
## WinP .   
## DS .   
## PSP .   
## GBA .   
## NES .   
## iOS .   
## SNES .   
## VC .   
## GC .   
## Ouya .   
## OR .   
## WW .   
## GEN .   
## MS .   
## Arc .   
## GB .   
## GG .   
## SCD .   
## DSi .   
## DSiW .   
## Mob .   
## S32X .   
## PS .   
## Number\_of\_Reviews .

coef(lasso3.cv, select="min") ## min cv selection

## 213 x 1 sparse Matrix of class "dgCMatrix"  
## seg30  
## intercept 9.80156515  
## (Intercept) .   
## year\_adj 0.28817953  
## Number.of.Reviews .   
## publisher2K Games 0.06480891  
## publisher3909 LLC .   
## publisher505 Games .   
## publisher5pb -0.06822589  
## publisher8-4 .   
## publisherActivision -0.27579261  
## publisherAksys Games .   
## publisherAmanita Design .   
## publisherAnnapurna Interactive .   
## publisherArc System Works .   
## publisherArena Entertainment .   
## publisherAtari -0.35893714  
## publisherAtlus .   
## publisherBandai Namco Entertainment .   
## publisherBedtime Digital Games .   
## publisherBerserk Games .   
## publisherBethesda Softworks .   
## publisherBinary Haze Interactive .   
## publisherBlizzard Entertainment .   
## publisherCapcom .   
## publisherCD Projekt .   
## publisherCD Projekt Red Studio -1.05330207  
## publisherCoffee Stain Publishing .   
## publisherCoffee Stain Studios .   
## publisherDECK13 Interactive GmbH .   
## publisherDeep Silver .   
## publisherDelightworks .   
## publisherDevolver Digital .   
## publisherDotEmu .   
## publisherDouble Fine Presents .   
## publisherDouble Fine Productions .   
## publisherDrinkBox Studios -0.62138595  
## publisherEA Sports -0.90755778  
## publisherEidos Interactive .   
## publisherElectronic Arts .   
## publisherEmber Lab .   
## publisherEndnight Games Ltd .   
## publisherFacepalm Games -0.06413979  
## publisherFinji .   
## publisherFocus Home Interactive .   
## publisherFrictional Games .   
## publisherFuncom .   
## publisherGalactic Cafe .   
## publisherGameMill Entertainment .   
## publisherGearbox Software 0.19925236  
## publisherGears for Breakfast .   
## publisherGR3 Project .   
## publisherGrinding Gear Games .   
## publisherGT Interactive .   
## publisherGun Media -0.27719615  
## publisherHi-Rez Studios .   
## publisherHumble Bundle .   
## publisherIgnition Entertainment .   
## publisherInti Creates .   
## publisherIO Interactive .   
## publisherJackbox Games -0.98609692  
## publisherJumpship .   
## publisherJupiter Corporation .   
## publisherKitfox Games .   
## publisherKonami .   
## publisherKonami Digital Entertainment .   
## publisherLevel 5 .   
## publisherLucasArts .   
## publisherMajesco .   
## publisherMarvelous .   
## publisherMatt Makes Games Inc. -0.85034570  
## publisherMedia.Vision -1.34187101  
## publisherMerge Games .   
## publisherMicrosoft Game Studios .   
## publisherMicrosoft Studios .   
## publishermiHoYo -0.28110640  
## publisherMTV Games .   
## publisherNamco .   
## publisherNamco Bandai .   
## publisherNamco Bandai Games .   
## publisherNdemic Creations .   
## publisherNicalis .   
## publisherNight School Studio .   
## publisherNintendo .   
## publisherNIS America .   
## publisherNumber None .   
## publisherPanic .   
## publisherParadox Interactive .   
## publisherPerfect World Entertainment .   
## publisherPillow Castle .   
## publisherPlaydead .   
## publisherPlaystack 0.34470376  
## publisherPlayStation PC .   
## publisherPolytron .   
## publisherPopCap Games .   
## publisherPrivate Division .   
## publisherRaw Fury .   
## publisherRebellion Developments .   
## publisherRebellion Games .   
## publisherRed Barrels .   
## publisherRed Hook Studios .   
## publisherRedOctane .   
## publisherRiot Games .   
## publisherRockstar Games .   
## publisherScott Cawthon .   
## publisherSega .   
## publisherSierra Entertainment .   
## publisherSloclap .   
## publisherSold Out .   
## publisherSony Computer Entertainment -0.20673384  
## publisherSony Computer Entertainment America .   
## publisherSony Interactive Entertainment .   
## publisherSony Online Entertainment -0.56285335  
## publisherSpike .   
## publisherSpike Chunsoft 0.24793572  
## publisherSpike Co. -0.05014687  
## publisherSquare-Enix .   
## publisherSquare Enix .   
## publisherStarbreeze Studios .   
## publisherSteel Crate Games .   
## publisherStudio MDHR -0.72480141  
## publisherSubset Games .   
## publisherSupergiant Games -0.04810391  
## publisherTake-Two Interactive .   
## publisherTeam 17 .   
## publisherTeam Cherry -0.67683650  
## publisherTeam Meat .   
## publisherTecmo 0.84751367  
## publisherTelltale Games .   
## publisherThe Behemoth .   
## publisherThe Indie Stone .   
## publisherThekla, Inc. .   
## publisherTHQ .   
## publisherThunder Lotus Games .   
## publisherTripwire Interactive .   
## publisherType-Moon .   
## publisherUbisoft .   
## publisherUnknown .   
## publisherValve 0.18836945  
## publisherValve Corporation .   
## publisherVivendi Games .   
## publisherWarner Bros. Interactive .   
## publisherWarner Bros. Interactive Entertainment -0.13716837  
## publisherWayForward .   
## publisherWayForward Technologies .   
## publisherWSS playground .   
## publisherWube Software LTD. .   
## publisherXbox Game Studios .   
## publisherXseed Games .   
## publisherYacht Club Games .   
## publisherYoung Horses .   
## publisherZA/UM .   
## genreAction-Adventure .   
## genreAdventure .   
## genreFighting -0.38899538  
## genreMisc -0.38266513  
## genreMMO .   
## genreMusic .   
## genreParty .   
## genrePlatform 0.11939623  
## genrePuzzle -0.28316267  
## genreRacing .   
## genreRole-Playing 0.12743845  
## genreShooter .   
## genreSimulation .   
## genreSports .   
## genreStrategy .   
## genreVisual Novel .   
## Rating 0.49954095  
## All .   
## PS4 0.18050296  
## NS .   
## PC .   
## OSX .   
## XOne .   
## PS5 .   
## XS 0.28139291  
## Series .   
## X360 .   
## XBL .   
## PS3 .   
## Wii -0.19780423  
## `3DS` .   
## PSV .   
## PS2 .   
## PSN .   
## WiiU -0.25482626  
## Linux .   
## XB .   
## And .   
## WinP .   
## DS .   
## PSP .   
## GBA .   
## NES .   
## iOS .   
## SNES .   
## VC .   
## GC .   
## Ouya .   
## OR .   
## WW 0.22627111  
## GEN .   
## MS .   
## Arc .   
## GB .   
## GG .   
## SCD .   
## DSi .   
## DSiW .   
## Mob .   
## S32X .   
## PS .   
## Number\_of\_Reviews .

## log lambdas selected under various criteria  
log\_lambdas <- function(cv\_obj) {  
 gamlr\_obj <- cv\_obj$gamlr  
 n\_lambdas <- length(gamlr\_obj$lambda)  
 n <- nrow(cv\_obj$gamlr$x)  
   
 # Calculate AIC, AICc, and BIC  
 aic\_values <- AIC(gamlr\_obj)  
 aicc\_values <- AICc(gamlr\_obj)  
 bic\_values <- BIC(gamlr\_obj)  
   
 # Extracting lambda values  
 lambda\_aicc <- gamlr\_obj$lambda[which.min(aicc\_values)]  
 lambda\_aic <- gamlr\_obj$lambda[which.min(aic\_values)]  
 lambda\_bic <- gamlr\_obj$lambda[which.min(bic\_values)]  
 lambda\_min <- cv\_obj$lambda.min  
 lambda\_1se <- cv\_obj$lambda.1se  
   
 return(list(lambda\_aicc = lambda\_aicc,  
 lambda\_aic = lambda\_aic,  
 lambda\_bic = lambda\_bic,  
 lambda\_min = lambda\_min,  
 lambda\_1se = lambda\_1se))  
}  
  
lambdas <- log\_lambdas(lasso3.cv)  
  
# Log lambdas  
log(lambdas$lambda\_aicc)

## seg31   
## -2.849217

log(lambdas$lambda\_aic)

## seg31   
## -2.849217

log(lambdas$lambda\_bic)

## seg14   
## -1.663037

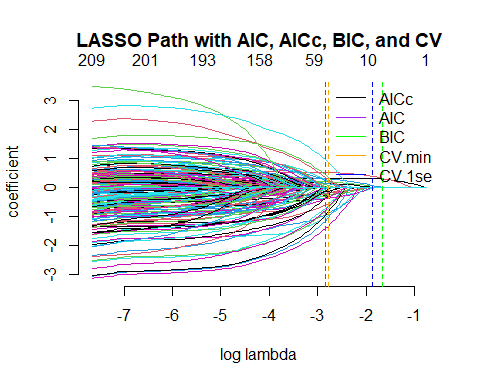
log(lambdas$lambda\_min)

## [1] -2.779441

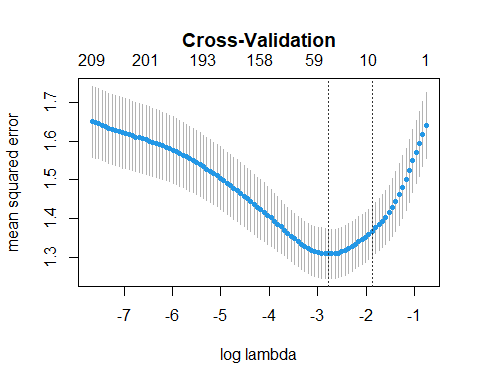
log(lambdas$lambda\_1se)

## [1] -1.872362

# Plot the cross-validation results with annotations  
# par(mfrow = c(1, 2))  
  
# Plot the LASSO path from gamlr  
plot(lasso3.cv$gamlr, main = "LASSO Path with AIC, AICc, BIC, and CV")  
  
# Adding vertical lines for the different criteria  
abline(v = log(lambdas$lambda\_aicc), col = "black", lty = 2)  
abline(v = log(lambdas$lambda\_aic), col = "purple", lty = 2)  
abline(v = log(lambdas$lambda\_bic), col = "green", lty = 2)  
abline(v = log(lambdas$lambda\_min), col = "orange", lty = 2)  
abline(v = log(lambdas$lambda\_1se), col = "blue", lty = 2)  
  
legend("topright", bty = "n", lwd = 1,   
 col = c("black", "purple", "green", "orange", "blue"),  
 legend = c("AICc", "AIC", "BIC", "CV.min", "CV.1se"))



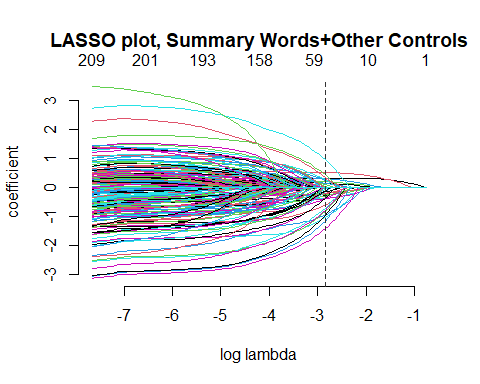
# Plot the cross-validation plot  
plot(lasso3.cv, main = "Cross-Validation")



y\_pred <- predict(lasso3.cv, x, select = "min")  
rss <- sum((game$log\_activePlayers - y\_pred)^2)  
tss <- sum((game$log\_activePlayers - mean(game$log\_activePlayers))^2)  
R2<- 1 - rss/tss

## LASSO summary

# Run lasso on genre, summary words, and year  
lasso\_sum <- gamlr(x, game$log\_activePlayers, standardize=TRUE, family = "gaussian", lambda.min.ratio=1e-3)  
plot(lasso\_sum, main="LASSO plot, Summary Words+Other Controls")



# in-sample R2  
1- lasso\_sum$deviance[which.min(AICc(lasso\_sum))]/lasso\_sum$deviance[1]

## seg31   
## 0.3292542

# Check coefficients  
lasso\_sum\_coef <- coef(lasso\_sum, select=which.min(AICc(lasso\_sum)))  
sum(lasso\_sum\_coef!=0)

## [1] 42

lasso\_sum\_coef <- as.data.frame(as.matrix(lasso\_sum\_coef))  
colnames(lasso\_sum\_coef) <- c("Coefficient")  
lasso\_sum\_coef$Feature <- rownames(lasso\_sum\_coef)  
rownames(lasso\_sum\_coef) <- NULL  
lasso\_sum\_coef\_sig <- lasso\_sum\_coef %>% filter(Coefficient != 0)%>% arrange(desc(Coefficient))  
lasso\_sum\_coef\_sig[-1, ]

## Coefficient Feature  
## 2 0.952945297 publisherTecmo  
## 3 0.503007573 Rating  
## 4 0.439778467 publisherPlaystack  
## 5 0.343782680 publisherSpike Chunsoft  
## 6 0.291466227 XS  
## 7 0.287874559 year\_adj  
## 8 0.269012439 WW  
## 9 0.262523978 publisherGearbox Software  
## 10 0.236434931 publisherValve  
## 11 0.190624626 PS4  
## 12 0.135694601 genrePlatform  
## 13 0.134095041 genreRole-Playing  
## 14 0.099524663 publisher2K Games  
## 15 0.007150816 publisherMajesco  
## 16 -0.022388551 publisherDouble Fine Productions  
## 17 -0.039255839 publisherXseed Games  
## 18 -0.071282214 publisherYoung Horses  
## 19 -0.137857847 publisherSupergiant Games  
## 20 -0.138160081 publisherSpike Co.  
## 21 -0.148139395 publisher5pb  
## 22 -0.163219845 publisherFacepalm Games  
## 23 -0.164912023 publisherWarner Bros. Interactive Entertainment  
## 24 -0.207074087 Wii  
## 25 -0.234755033 publisherSony Computer Entertainment  
## 26 -0.258648191 WiiU  
## 27 -0.302193906 publisherActivision  
## 28 -0.311427021 genrePuzzle  
## 29 -0.388118503 publisherGun Media  
## 30 -0.391853660 publishermiHoYo  
## 31 -0.393678113 genreMisc  
## 32 -0.402731969 genreFighting  
## 33 -0.408204918 publisherAtari  
## 34 -0.621025815 publisherSony Online Entertainment  
## 35 -0.731835757 publisherDrinkBox Studios  
## 36 -0.793979359 publisherTeam Cherry  
## 37 -0.840907554 publisherStudio MDHR  
## 38 -0.962552382 publisherEA Sports  
## 39 -0.983015925 publisherMatt Makes Games Inc.  
## 40 -1.058395609 publisherJackbox Games  
## 41 -1.176500874 publisherCD Projekt Red Studio  
## 42 -1.444017293 publisherMedia.Vision

library(gamlr)  
lasso\_sum.cv <- cv.gamlr(x, game$log\_activePlayers, lambda.min.ratio = 1e-3,  
 family = "gaussian", verb = TRUE)

## fold 1,2,3,4,5,done.

sum(coef(lasso\_sum.cv)!=0) # 1se

## [1] 7

sum(coef(lasso\_sum.cv, s="min")!=0) # min

## [1] 33

sum(coef(lasso\_sum.cv$gamlr)!=0) # AICc

## [1] 42

set.seed(1234)  
# CROSS-VALIDATION  
coef(lasso\_sum.cv) ## 1se rule; see ?cv.gamlr

## 213 x 1 sparse Matrix of class "dgCMatrix"  
## seg17  
## intercept 10.26533584  
## (Intercept) .   
## year\_adj 0.29430633  
## Number.of.Reviews .   
## publisher2K Games .   
## publisher3909 LLC .   
## publisher505 Games .   
## publisher5pb .   
## publisher8-4 .   
## publisherActivision .   
## publisherAksys Games .   
## publisherAmanita Design .   
## publisherAnnapurna Interactive .   
## publisherArc System Works .   
## publisherArena Entertainment .   
## publisherAtari .   
## publisherAtlus .   
## publisherBandai Namco Entertainment .   
## publisherBedtime Digital Games .   
## publisherBerserk Games .   
## publisherBethesda Softworks .   
## publisherBinary Haze Interactive .   
## publisherBlizzard Entertainment .   
## publisherCapcom .   
## publisherCD Projekt .   
## publisherCD Projekt Red Studio .   
## publisherCoffee Stain Publishing .   
## publisherCoffee Stain Studios .   
## publisherDECK13 Interactive GmbH .   
## publisherDeep Silver .   
## publisherDelightworks .   
## publisherDevolver Digital .   
## publisherDotEmu .   
## publisherDouble Fine Presents .   
## publisherDouble Fine Productions .   
## publisherDrinkBox Studios .   
## publisherEA Sports .   
## publisherEidos Interactive .   
## publisherElectronic Arts .   
## publisherEmber Lab .   
## publisherEndnight Games Ltd .   
## publisherFacepalm Games .   
## publisherFinji .   
## publisherFocus Home Interactive .   
## publisherFrictional Games .   
## publisherFuncom .   
## publisherGalactic Cafe .   
## publisherGameMill Entertainment .   
## publisherGearbox Software .   
## publisherGears for Breakfast .   
## publisherGR3 Project .   
## publisherGrinding Gear Games .   
## publisherGT Interactive .   
## publisherGun Media .   
## publisherHi-Rez Studios .   
## publisherHumble Bundle .   
## publisherIgnition Entertainment .   
## publisherInti Creates .   
## publisherIO Interactive .   
## publisherJackbox Games .   
## publisherJumpship .   
## publisherJupiter Corporation .   
## publisherKitfox Games .   
## publisherKonami .   
## publisherKonami Digital Entertainment .   
## publisherLevel 5 .   
## publisherLucasArts .   
## publisherMajesco .   
## publisherMarvelous .   
## publisherMatt Makes Games Inc. .   
## publisherMedia.Vision .   
## publisherMerge Games .   
## publisherMicrosoft Game Studios .   
## publisherMicrosoft Studios .   
## publishermiHoYo .   
## publisherMTV Games .   
## publisherNamco .   
## publisherNamco Bandai .   
## publisherNamco Bandai Games .   
## publisherNdemic Creations .   
## publisherNicalis .   
## publisherNight School Studio .   
## publisherNintendo .   
## publisherNIS America .   
## publisherNumber None .   
## publisherPanic .   
## publisherParadox Interactive .   
## publisherPerfect World Entertainment .   
## publisherPillow Castle .   
## publisherPlaydead .   
## publisherPlaystack .   
## publisherPlayStation PC .   
## publisherPolytron .   
## publisherPopCap Games .   
## publisherPrivate Division .   
## publisherRaw Fury .   
## publisherRebellion Developments .   
## publisherRebellion Games .   
## publisherRed Barrels .   
## publisherRed Hook Studios .   
## publisherRedOctane .   
## publisherRiot Games .   
## publisherRockstar Games .   
## publisherScott Cawthon .   
## publisherSega .   
## publisherSierra Entertainment .   
## publisherSloclap .   
## publisherSold Out .   
## publisherSony Computer Entertainment .   
## publisherSony Computer Entertainment America .   
## publisherSony Interactive Entertainment .   
## publisherSony Online Entertainment .   
## publisherSpike .   
## publisherSpike Chunsoft .   
## publisherSpike Co. .   
## publisherSquare-Enix .   
## publisherSquare Enix .   
## publisherStarbreeze Studios .   
## publisherSteel Crate Games .   
## publisherStudio MDHR .   
## publisherSubset Games .   
## publisherSupergiant Games .   
## publisherTake-Two Interactive .   
## publisherTeam 17 .   
## publisherTeam Cherry .   
## publisherTeam Meat .   
## publisherTecmo .   
## publisherTelltale Games .   
## publisherThe Behemoth .   
## publisherThe Indie Stone .   
## publisherThekla, Inc. .   
## publisherTHQ .   
## publisherThunder Lotus Games .   
## publisherTripwire Interactive .   
## publisherType-Moon .   
## publisherUbisoft .   
## publisherUnknown .   
## publisherValve .   
## publisherValve Corporation .   
## publisherVivendi Games .   
## publisherWarner Bros. Interactive .   
## publisherWarner Bros. Interactive Entertainment .   
## publisherWayForward .   
## publisherWayForward Technologies .   
## publisherWSS playground .   
## publisherWube Software LTD. .   
## publisherXbox Game Studios .   
## publisherXseed Games .   
## publisherYacht Club Games .   
## publisherYoung Horses .   
## publisherZA/UM .   
## genreAction-Adventure .   
## genreAdventure .   
## genreFighting -0.01712225  
## genreMisc -0.04561207  
## genreMMO .   
## genreMusic .   
## genreParty .   
## genrePlatform .   
## genrePuzzle .   
## genreRacing .   
## genreRole-Playing .   
## genreShooter .   
## genreSimulation .   
## genreSports .   
## genreStrategy .   
## genreVisual Novel .   
## Rating 0.37761097  
## All .   
## PS4 0.04139997  
## NS .   
## PC .   
## OSX .   
## XOne .   
## PS5 .   
## XS 0.06300609  
## Series .   
## X360 .   
## XBL .   
## PS3 .   
## Wii .   
## `3DS` .   
## PSV .   
## PS2 .   
## PSN .   
## WiiU .   
## Linux .   
## XB .   
## And .   
## WinP .   
## DS .   
## PSP .   
## GBA .   
## NES .   
## iOS .   
## SNES .   
## VC .   
## GC .   
## Ouya .   
## OR .   
## WW .   
## GEN .   
## MS .   
## Arc .   
## GB .   
## GG .   
## SCD .   
## DSi .   
## DSiW .   
## Mob .   
## S32X .   
## PS .   
## Number\_of\_Reviews .

coef(lasso\_sum.cv, select="min") ## min cv selection

## 213 x 1 sparse Matrix of class "dgCMatrix"  
## seg28  
## intercept 9.83397188  
## (Intercept) .   
## year\_adj 0.28765298  
## Number.of.Reviews .   
## publisher2K Games .   
## publisher3909 LLC .   
## publisher505 Games .   
## publisher5pb .   
## publisher8-4 .   
## publisherActivision -0.22021950  
## publisherAksys Games .   
## publisherAmanita Design .   
## publisherAnnapurna Interactive .   
## publisherArc System Works .   
## publisherArena Entertainment .   
## publisherAtari -0.24885867  
## publisherAtlus .   
## publisherBandai Namco Entertainment .   
## publisherBedtime Digital Games .   
## publisherBerserk Games .   
## publisherBethesda Softworks .   
## publisherBinary Haze Interactive .   
## publisherBlizzard Entertainment .   
## publisherCapcom .   
## publisherCD Projekt .   
## publisherCD Projekt Red Studio -0.78537229  
## publisherCoffee Stain Publishing .   
## publisherCoffee Stain Studios .   
## publisherDECK13 Interactive GmbH .   
## publisherDeep Silver .   
## publisherDelightworks .   
## publisherDevolver Digital .   
## publisherDotEmu .   
## publisherDouble Fine Presents .   
## publisherDouble Fine Productions .   
## publisherDrinkBox Studios -0.39028189  
## publisherEA Sports -0.78927393  
## publisherEidos Interactive .   
## publisherElectronic Arts .   
## publisherEmber Lab .   
## publisherEndnight Games Ltd .   
## publisherFacepalm Games .   
## publisherFinji .   
## publisherFocus Home Interactive .   
## publisherFrictional Games .   
## publisherFuncom .   
## publisherGalactic Cafe .   
## publisherGameMill Entertainment .   
## publisherGearbox Software 0.05388226  
## publisherGears for Breakfast .   
## publisherGR3 Project .   
## publisherGrinding Gear Games .   
## publisherGT Interactive .   
## publisherGun Media -0.03408874  
## publisherHi-Rez Studios .   
## publisherHumble Bundle .   
## publisherIgnition Entertainment .   
## publisherInti Creates .   
## publisherIO Interactive .   
## publisherJackbox Games -0.82512957  
## publisherJumpship .   
## publisherJupiter Corporation .   
## publisherKitfox Games .   
## publisherKonami .   
## publisherKonami Digital Entertainment .   
## publisherLevel 5 .   
## publisherLucasArts .   
## publisherMajesco .   
## publisherMarvelous .   
## publisherMatt Makes Games Inc. -0.55746675  
## publisherMedia.Vision -1.11533566  
## publisherMerge Games .   
## publisherMicrosoft Game Studios .   
## publisherMicrosoft Studios .   
## publishermiHoYo -0.03769593  
## publisherMTV Games .   
## publisherNamco .   
## publisherNamco Bandai .   
## publisherNamco Bandai Games .   
## publisherNdemic Creations .   
## publisherNicalis .   
## publisherNight School Studio .   
## publisherNintendo .   
## publisherNIS America .   
## publisherNumber None .   
## publisherPanic .   
## publisherParadox Interactive .   
## publisherPerfect World Entertainment .   
## publisherPillow Castle .   
## publisherPlaydead .   
## publisherPlaystack 0.13017573  
## publisherPlayStation PC .   
## publisherPolytron .   
## publisherPopCap Games .   
## publisherPrivate Division .   
## publisherRaw Fury .   
## publisherRebellion Developments .   
## publisherRebellion Games .   
## publisherRed Barrels .   
## publisherRed Hook Studios .   
## publisherRedOctane .   
## publisherRiot Games .   
## publisherRockstar Games .   
## publisherScott Cawthon .   
## publisherSega .   
## publisherSierra Entertainment .   
## publisherSloclap .   
## publisherSold Out .   
## publisherSony Computer Entertainment -0.14717059  
## publisherSony Computer Entertainment America .   
## publisherSony Interactive Entertainment .   
## publisherSony Online Entertainment -0.43389737  
## publisherSpike .   
## publisherSpike Chunsoft 0.02972064  
## publisherSpike Co. .   
## publisherSquare-Enix .   
## publisherSquare Enix .   
## publisherStarbreeze Studios .   
## publisherSteel Crate Games .   
## publisherStudio MDHR -0.46998261  
## publisherSubset Games .   
## publisherSupergiant Games .   
## publisherTake-Two Interactive .   
## publisherTeam 17 .   
## publisherTeam Cherry -0.41967485  
## publisherTeam Meat .   
## publisherTecmo 0.61136856  
## publisherTelltale Games .   
## publisherThe Behemoth .   
## publisherThe Indie Stone .   
## publisherThekla, Inc. .   
## publisherTHQ .   
## publisherThunder Lotus Games .   
## publisherTripwire Interactive .   
## publisherType-Moon .   
## publisherUbisoft .   
## publisherUnknown .   
## publisherValve 0.08115914  
## publisherValve Corporation .   
## publisherVivendi Games .   
## publisherWarner Bros. Interactive .   
## publisherWarner Bros. Interactive Entertainment -0.08054003  
## publisherWayForward .   
## publisherWayForward Technologies .   
## publisherWSS playground .   
## publisherWube Software LTD. .   
## publisherXbox Game Studios .   
## publisherXseed Games .   
## publisherYacht Club Games .   
## publisherYoung Horses .   
## publisherZA/UM .   
## genreAction-Adventure .   
## genreAdventure .   
## genreFighting -0.36081621  
## genreMisc -0.35142451  
## genreMMO .   
## genreMusic .   
## genreParty .   
## genrePlatform 0.08217377  
## genrePuzzle -0.22190836  
## genreRacing .   
## genreRole-Playing 0.11327197  
## genreShooter .   
## genreSimulation .   
## genreSports .   
## genreStrategy .   
## genreVisual Novel .   
## Rating 0.49170648  
## All .   
## PS4 0.16208685  
## NS .   
## PC .   
## OSX .   
## XOne .   
## PS5 .   
## XS 0.26227016  
## Series .   
## X360 .   
## XBL .   
## PS3 .   
## Wii -0.17907746  
## `3DS` .   
## PSV .   
## PS2 .   
## PSN .   
## WiiU -0.23616817  
## Linux .   
## XB .   
## And .   
## WinP .   
## DS .   
## PSP .   
## GBA .   
## NES .   
## iOS .   
## SNES .   
## VC .   
## GC .   
## Ouya .   
## OR .   
## WW 0.12963395  
## GEN .   
## MS .   
## Arc .   
## GB .   
## GG .   
## SCD .   
## DSi .   
## DSiW .   
## Mob .   
## S32X .   
## PS .   
## Number\_of\_Reviews .

## log lambdas selected under various criteria  
log\_lambdas <- function(cv\_obj) {  
 gamlr\_obj <- cv\_obj$gamlr  
 n\_lambdas <- length(gamlr\_obj$lambda)  
 n <- nrow(cv\_obj$gamlr$x)  
   
 # Calculate AIC, AICc, and BIC  
 aic\_values <- AIC(gamlr\_obj)  
 aicc\_values <- AICc(gamlr\_obj)  
 bic\_values <- BIC(gamlr\_obj)  
   
 # Extracting lambda values  
 lambda\_aicc <- gamlr\_obj$lambda[which.min(aicc\_values)]  
 lambda\_aic <- gamlr\_obj$lambda[which.min(aic\_values)]  
 lambda\_bic <- gamlr\_obj$lambda[which.min(bic\_values)]  
 lambda\_min <- cv\_obj$lambda.min  
 lambda\_1se <- cv\_obj$lambda.1se  
   
 return(list(lambda\_aicc = lambda\_aicc,  
 lambda\_aic = lambda\_aic,  
 lambda\_bic = lambda\_bic,  
 lambda\_min = lambda\_min,  
 lambda\_1se = lambda\_1se))  
}  
  
lambdas <- log\_lambdas(lasso\_sum.cv)  
  
# Log lambdas  
log(lambdas$lambda\_aicc)

## seg31   
## -2.849217

log(lambdas$lambda\_aic)

## seg31   
## -2.849217

log(lambdas$lambda\_bic)

## seg14   
## -1.663037

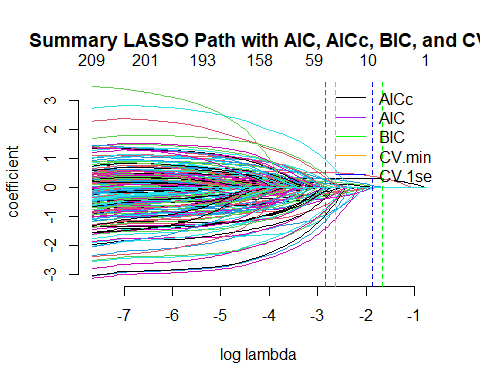
log(lambdas$lambda\_min)

## [1] -2.639891

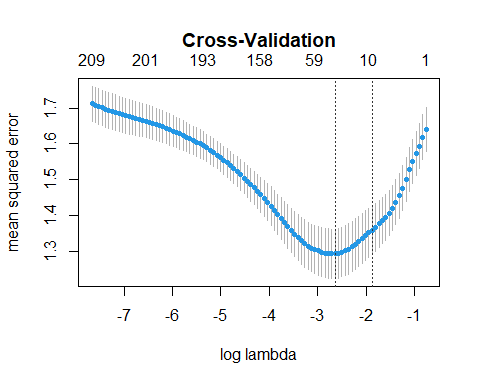
log(lambdas$lambda\_1se)

## [1] -1.872362

# Plot the LASSO path from gamlr  
plot(lasso\_sum.cv$gamlr, main = "Summary LASSO Path with AIC, AICc, BIC, and CV")  
  
# Adding vertical lines for the different criteria  
abline(v = log(lambdas$lambda\_aicc), col = "black", lty = 2)  
abline(v = log(lambdas$lambda\_aic), col = "purple", lty = 2)  
abline(v = log(lambdas$lambda\_bic), col = "green", lty = 2)  
abline(v = log(lambdas$lambda\_min), col = "orange", lty = 2)  
abline(v = log(lambdas$lambda\_1se), col = "blue", lty = 2)  
  
legend("topright", bty = "n", lwd = 1,   
 col = c("black", "purple", "green", "orange", "blue"),  
 legend = c("AICc", "AIC", "BIC", "CV.min", "CV.1se"))



# Plot the cross-validation plot  
plot(lasso\_sum.cv, main = "Cross-Validation")



## OOS R2

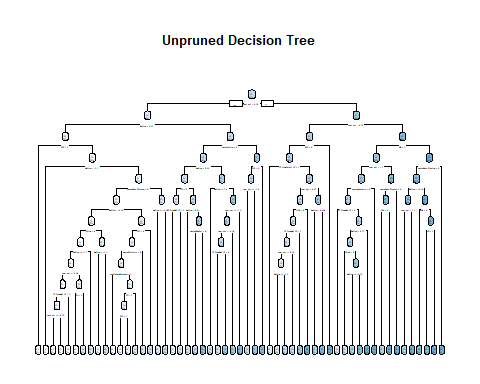
## OOS R2 LASSO

library(glmnet)  
library(gamlr)  
library(ggplot2)  
set.seed(1234)  
  
## Combine x   
genre\_dummies <- model.matrix(~ genre - 1, data = game)  
year\_cont <- model.matrix(~ year\_adj, data = game)  
publisher\_dummies <- model.matrix(~ publisher - 1, data = game)  
game$Rating <- as.numeric(game$Rating)  
rating\_cont <- model.matrix(~ Rating, data = game)  
ip\_dummies <- model.matrix(~ IP\_Type - 1, data = game)  
x <- cbind(genre\_dummies, year\_cont, publisher\_dummies, rating\_cont, ip\_dummies, tdm\_sparse, console\_sparse)  
x <- as(x, "sparseMatrix")  
  
# Function to split data and calculate OOS R² for LASSO  
calculate\_oos\_r2 <- function(x, y, train\_fraction = 0.7, n\_splits = 20) {  
 oos\_r2\_values <- numeric(n\_splits)  
   
 for (i in 1:n\_splits) {  
 # Split data into training and testing sets  
 train\_indices <- sample(1:nrow(x), size = floor(train\_fraction \* nrow(x)))  
 test\_indices <- setdiff(1:nrow(x), train\_indices)  
   
 x\_train <- x[train\_indices, ]  
 y\_train <- y[train\_indices]  
 x\_test <- x[test\_indices, ]  
 y\_test <- y[test\_indices]  
   
 # Fit LASSO model  
 lasso\_model <- cv.gamlr(x\_train, y\_train, lambda.min.ratio = 1e-3, family = "gaussian")  
   
 # Predict on test set using the lambda with minimum cross-validated error  
 y\_pred <- predict(lasso\_model, x\_test, select = "min")  
   
 # Calculate OOS R²  
 rss <- sum((y\_test - y\_pred)^2)  
 tss <- sum((y\_test - mean(y\_test))^2)  
 oos\_r2 <- 1 - rss/tss  
   
 oos\_r2\_values[i] <- oos\_r2  
 }  
   
 return(oos\_r2\_values)  
}  
  
# Apply function to your data  
x <- as.matrix(x) # Ensure x is a matrix  
y <- game$log\_activePlayers  
oos\_r2\_lasso <- calculate\_oos\_r2(x, y)  
  
# Repeat for other models and collect their OOS R² values  
# For brevity, only LASSO is shown here. Extend similarly for other models.  
  
  
# Combine OOS R² values into a data frame  
model\_names <- rep(c("LASSO"), each = 20) # Extend with other model names  
oos\_r2\_values <- c(oos\_r2\_lasso) # Combine with other OOS R² values  
  
results\_df <- data.frame(model = model\_names, OOS\_R2 = oos\_r2\_values)

## Unpruned tree

library(rpart)  
library(rpart.plot)  
  
genre\_df <- as.data.frame(model.matrix(~ genre - 1, data = game))  
publisher\_df <- as.data.frame(model.matrix(~ publisher - 1, data = game))  
ip\_df <- model.matrix(~ IP\_Type - 1, data = game)  
tdm\_df <- as.data.frame(as.matrix(tdm\_sparse))  
x\_tree <- cbind(game[, c("year\_adj", "Rating")], genre\_df, publisher\_df, ip\_df, console\_df) # , tdm\_df  
x\_tree$year\_adj <- scale(x\_tree$year\_adj)  
x\_tree$Rating <- scale(x\_tree$Rating)  
  
# Fit the unpruned decision tree model  
tree\_model <- rpart(game$log\_activePlayers ~ ., data = data.frame(x\_tree), control = rpart.control(cp = 0))  
  
# Plot the unpruned tree  
rpart.plot(tree\_model, main = "Unpruned Decision Tree")

## Warning: labs do not fit even at cex 0.15, there may be some overplotting



pdf("unpruned\_tree\_plot.pdf", width = 8, height = 6)  
rpart.plot(tree\_model, main = "Unpruned Decision Tree")  
dev.off()

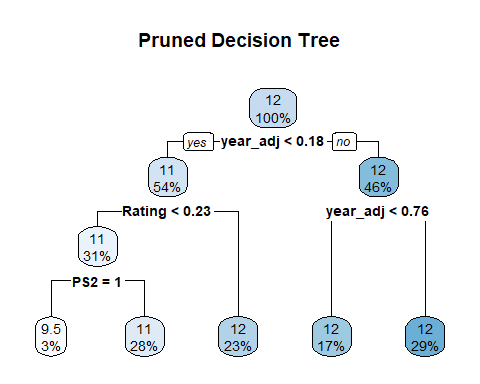
## png   
## 2

# Function to split data and calculate OOS R² for the unpruned tree  
calculate\_oos\_r2\_tree <- function(x, y, train\_fraction = 0.7, n\_splits = 20) {  
 oos\_r2\_values <- numeric(n\_splits)  
   
 for (i in 1:n\_splits) {  
 # Split data into training and testing sets  
 train\_indices <- sample(1:nrow(x), size = floor(train\_fraction \* nrow(x)))  
 test\_indices <- setdiff(1:nrow(x), train\_indices)  
   
 x\_train <- x[train\_indices, ]  
 y\_train <- y[train\_indices]  
 x\_test <- x[test\_indices, ]  
 y\_test <- y[test\_indices]  
   
 # Fit the unpruned decision tree model  
 tree\_model <- rpart(y\_train ~ ., data = data.frame(x\_train), control = rpart.control(cp = 0))  
   
 # Predict on the test set  
 y\_pred <- predict(tree\_model, newdata = data.frame(x\_test))  
   
 # Calculate OOS R²  
 rss <- sum((y\_test - y\_pred)^2)  
 tss <- sum((y\_test - mean(y\_test))^2)  
 oos\_r2 <- 1 - rss/tss  
   
 oos\_r2\_values[i] <- oos\_r2  
 }  
   
 return(oos\_r2\_values)  
}  
  
# Apply function to your data  
oos\_r2\_tree <- calculate\_oos\_r2\_tree(x\_tree, game$log\_activePlayers)  
  
# Combine OOS R² values into a data frame  
# model\_names <- rep(c("LASSO\_AICc", "LASSO\_CVmin", "Tree\_Unpruned"), each = 20)  
# oos\_r2\_values <- c(oos\_r2\_results$oos\_r2\_aicc, oos\_r2\_results$oos\_r2\_cv\_min, oos\_r2\_tree)  
#   
# results\_df <- data.frame(model = model\_names, OOS\_R2 = oos\_r2\_values)  
  
# # Plot using ggplot2  
# ggplot(results\_df, aes(x = model, y = OOS\_R2)) +  
# geom\_boxplot(fill = "purple", color = "black") +  
# theme\_minimal() +  
# labs(title = "OOS R² Comparison for LASSO and Unpruned Tree", x = "Model", y = "OOS R²") +  
# theme(plot.title = element\_text(hjust = 0.5))

# Prune the tree based on the cp that minimizes cross-validated error  
cp\_table <- printcp(tree\_model)

##   
## Regression tree:  
## rpart(formula = game$log\_activePlayers ~ ., data = data.frame(x\_tree),   
## control = rpart.control(cp = 0))  
##   
## Variables actually used in tree construction:  
## [1] All genreAction genreAdventure genrePlatform   
## [5] genreRole.Playing genreShooter IP\_TypeNot.IP IP\_TypeSmall.IP   
## [9] NS OSX PC PS2   
## [13] PS3 PS4 PS5 publisherNintendo  
## [17] Rating XOne XS year\_adj   
##   
## Root node error: 1062/648 = 1.6389  
##   
## n= 648   
##   
## CP nsplit rel error xerror xstd  
## 1 0.14631328 0 1.00000 1.00493 0.052305  
## 2 0.07237197 1 0.85369 0.87250 0.049656  
## 3 0.03281006 2 0.78131 0.81401 0.047317  
## 4 0.01564264 3 0.74850 0.79276 0.045053  
## 5 0.01236856 4 0.73286 0.77532 0.045875  
## 6 0.00875069 5 0.72049 0.78510 0.047129  
## 7 0.00729957 6 0.71174 0.78832 0.046981  
## 8 0.00703008 9 0.68984 0.78945 0.047292  
## 9 0.00660590 10 0.68281 0.79062 0.048658  
## 10 0.00607271 13 0.66173 0.81210 0.049977  
## 11 0.00535220 16 0.64351 0.82295 0.050523  
## 12 0.00519813 18 0.63281 0.82879 0.050628  
## 13 0.00452917 19 0.62761 0.82188 0.050173  
## 14 0.00414101 22 0.61402 0.83337 0.050443  
## 15 0.00367394 23 0.60988 0.83630 0.050693  
## 16 0.00349528 24 0.60621 0.84127 0.050765  
## 17 0.00338884 25 0.60271 0.84686 0.050518  
## 18 0.00327202 26 0.59932 0.85190 0.051112  
## 19 0.00313580 28 0.59278 0.85387 0.050879  
## 20 0.00285690 29 0.58964 0.85642 0.051014  
## 21 0.00282322 31 0.58393 0.86065 0.051137  
## 22 0.00273229 32 0.58111 0.86291 0.050266  
## 23 0.00267591 34 0.57564 0.85888 0.050055  
## 24 0.00263935 35 0.57297 0.85670 0.050053  
## 25 0.00242814 37 0.56769 0.85857 0.050201  
## 26 0.00229782 38 0.56526 0.86522 0.050378  
## 27 0.00225543 39 0.56296 0.86399 0.050398  
## 28 0.00201438 40 0.56071 0.86726 0.050374  
## 29 0.00201363 41 0.55869 0.86810 0.050496  
## 30 0.00199290 42 0.55668 0.86810 0.050496  
## 31 0.00177954 43 0.55468 0.86676 0.050673  
## 32 0.00158171 44 0.55290 0.87309 0.050305  
## 33 0.00134837 45 0.55132 0.88265 0.050646  
## 34 0.00119135 46 0.54997 0.88647 0.050925  
## 35 0.00112065 48 0.54759 0.88557 0.050816  
## 36 0.00095332 49 0.54647 0.88390 0.050521  
## 37 0.00094098 50 0.54552 0.88459 0.050521  
## 38 0.00086276 51 0.54458 0.88409 0.050514  
## 39 0.00072193 53 0.54285 0.88435 0.050446  
## 40 0.00000000 54 0.54213 0.88371 0.050436

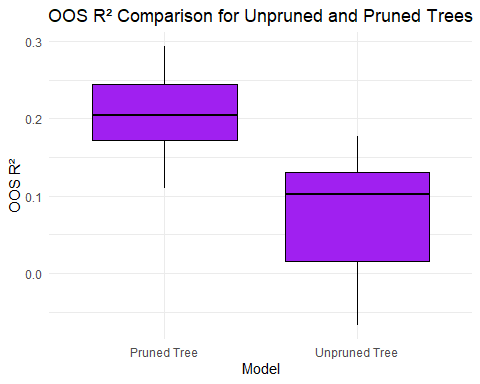
best\_cp <- cp\_table[which.min(cp\_table[, "xerror"]), "CP"]  
pruned\_tree <- prune(tree\_model, cp = best\_cp)  
  
# Plot the pruned tree  
rpart.plot(pruned\_tree, main = "Pruned Decision Tree")



pdf("pruned\_tree\_plot.pdf", width = 8, height = 6)  
rpart.plot(pruned\_tree, main = "Pruned Decision Tree")  
dev.off()

## png   
## 2

# Function to calculate OOS R² for a given tree model  
calculate\_oos\_r2\_tree <- function(x, y, tree\_control, train\_fraction = 0.7, n\_splits = 20) {  
 oos\_r2\_values <- numeric(n\_splits)  
   
 for (i in 1:n\_splits) {  
 # Split data into training and testing sets  
 train\_indices <- sample(1:nrow(x), size = floor(train\_fraction \* nrow(x)))  
 test\_indices <- setdiff(1:nrow(x), train\_indices)  
   
 x\_train <- x[train\_indices, ]  
 y\_train <- y[train\_indices]  
 x\_test <- x[test\_indices, ]  
 y\_test <- y[test\_indices]  
   
 # Fit the tree model  
 tree\_model <- rpart(y\_train ~ ., data = data.frame(x\_train), control = tree\_control)  
   
 # Predict on the test set  
 y\_pred <- predict(tree\_model, newdata = data.frame(x\_test))  
   
 # Calculate OOS R²  
 rss <- sum((y\_test - y\_pred)^2)  
 tss <- sum((y\_test - mean(y\_test))^2)  
 oos\_r2 <- 1 - rss/tss  
   
 oos\_r2\_values[i] <- oos\_r2  
 }  
   
 return(oos\_r2\_values)  
}  
  
# Apply function to your data for unpruned tree  
unpruned\_control <- rpart.control(cp = 0)  
oos\_r2\_unpruned <- calculate\_oos\_r2\_tree(x\_tree, game$log\_activePlayers, unpruned\_control)  
  
# Apply function to your data for pruned tree  
pruned\_control <- rpart.control(cp = best\_cp)  
oos\_r2\_pruned <- calculate\_oos\_r2\_tree(x\_tree, game$log\_activePlayers, pruned\_control)  
  
# Combine OOS R² values into a data frame  
model\_names <- rep(c("Unpruned Tree", "Pruned Tree"), each = 20)  
oos\_r2\_values <- c(oos\_r2\_unpruned, oos\_r2\_pruned)  
  
results\_df <- data.frame(model = model\_names, OOS\_R2 = oos\_r2\_values)  
  
# Plot using ggplot2  
ggplot(results\_df, aes(x = model, y = OOS\_R2)) +  
 geom\_boxplot(fill = "purple", color = "black") +  
 theme\_minimal() +  
 labs(title = "OOS R² Comparison for Unpruned and Pruned Trees", x = "Model", y = "OOS R²") +  
 theme(plot.title = element\_text(hjust = 0.5))



## Random Forest

# Convert factors to numeric  
x\_tree <- cbind(game[, c("year\_adj", "Rating")], genre\_df, publisher\_df, ip\_df, console\_df)  
x\_tree$year\_adj <- scale(x\_tree$year\_adj)  
x\_tree$Rating <- scale(x\_tree$Rating)  
x\_tree <- data.frame(lapply(x\_tree, function(x) if(is.factor(x)) as.numeric(x) else x))  
  
# Fit the Random Forest model  
rf\_model <- randomForest(game$log\_activePlayers ~ ., data = data.frame(x\_tree), ntree = 500, importance = TRUE)  
print(rf\_model)

##   
## Call:  
## randomForest(formula = game$log\_activePlayers ~ ., data = data.frame(x\_tree), ntree = 500, importance = TRUE)   
## Type of random forest: regression  
## Number of trees: 500  
## No. of variables tried at each split: 71  
##   
## Mean of squared residuals: 1.279812  
## % Var explained: 21.91

# Plot the importance of variables  
png("variable\_importance\_plot.png", width = 1200, height = 800)  
par(mar = c(5, 15, 4, 2) + 0.1)  
varImpPlot(rf\_model, main = "Variable Importance Plot", n.var = min(30, nrow(rf\_model$importance)))  
dev.off()

## png   
## 2

# Function to split data and calculate OOS R² for Random Forest  
calculate\_oos\_r2\_rf <- function(x, y, train\_fraction = 0.7, n\_splits = 20) {  
 oos\_r2\_values <- numeric(n\_splits)  
   
 for (i in 1:n\_splits) {  
 # Split data into training and testing sets  
 train\_indices <- sample(1:nrow(x), size = floor(train\_fraction \* nrow(x)))  
 test\_indices <- setdiff(1:nrow(x), train\_indices)  
   
 x\_train <- x[train\_indices, ]  
 y\_train <- y[train\_indices]  
 x\_test <- x[test\_indices, ]  
 y\_test <- y[test\_indices]  
   
 # Fit the Random Forest model  
 rf\_model <- randomForest(y\_train ~ ., data = data.frame(x\_train), ntree = 500)  
   
 # Predict on the test set  
 y\_pred <- predict(rf\_model, newdata = data.frame(x\_test))  
   
 # Calculate OOS R2  
 rss <- sum((y\_test - y\_pred)^2)  
 tss <- sum((y\_test - mean(y\_test))^2)  
 oos\_r2 <- 1 - rss/tss  
   
 oos\_r2\_values[i] <- oos\_r2  
 }  
   
 return(oos\_r2\_values)  
}  
  
  
x <- as.matrix(x\_tree)  
y <- game$log\_activePlayers  
oos\_r2\_rf <- calculate\_oos\_r2\_rf(x, y)

# # Combine OOS R² values into a data frame  
# model\_names <- rep(c("LASSO\_AICc", "LASSO\_CVmin", "Tree\_Unpruned", "Tree\_Pruned", "RF"), each = 20)  
# oos\_r2\_values <- c(oos\_r2\_results$oos\_r2\_aicc, oos\_r2\_results$oos\_r2\_cv\_min, oos\_r2\_tree, oos\_r2\_pruned, oos\_r2\_rf)  
#   
# results\_df <- data.frame(model = model\_names, OOS\_R2 = oos\_r2\_values)  
#   
# # Plot using ggplot2  
# ggplot(results\_df, aes(x = model, y = OOS\_R2)) +  
# geom\_boxplot(fill = "purple", color = "black") +  
# theme\_minimal() +  
# labs(title = "OOS R² Comparison for LASSO, Trees, and Random Forest", x = "Model", y = "OOS R²") +  
# theme(plot.title = element\_text(hjust = 0.5))

## KNN

set.seed(1234)  
# Selecting columns and creating model matrix  
publisher\_dummies <- model.matrix(~ publisher - 1, data = game)  
developer\_dummies <- model.matrix(~ developer - 1, data = game)  
genre\_dummies <- model.matrix(~ genre - 1, data = game)  
developer\_dummies <- model.matrix(~ developer - 1, data = game)  
ip\_dummies <- model.matrix(~ IP\_Type - 1, data = game)  
year\_cont <- model.matrix(~ year\_adj, data = game)  
rating\_cont <- model.matrix(~ Rating, data = game)  
  
predictors\_knn <- cbind(year\_cont, genre\_dummies, rating\_cont, publisher\_dummies, developer\_dummies, ip\_dummies, tdm\_sparse, console\_sparse)  
predictors\_knn <- as(predictors\_knn, "sparseMatrix")

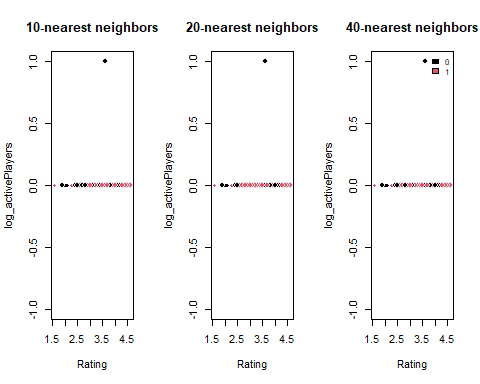
set.seed(1234)  
quantiles <- quantile(game$activePlayers, probs=c(0, 0.5, 1), na.rm=TRUE)  
y <- cut(game$activePlayers, breaks=quantiles, include.lowest=TRUE, labels=c(0, 1))  
train <- createDataPartition(y, p = 0.5, list = FALSE)  
  
## Compare K = 10, 20, 40  
set.seed(1234)  
nearest10 <- class::knn(train=predictors\_knn[train,], test=predictors\_knn[-train,], cl=y[train], prob=TRUE, k=10)   
nearest20 <- class::knn(train=predictors\_knn[train,], test=predictors\_knn[-train,], cl=y[train], prob=TRUE, k=20)   
nearest40 <- class::knn(train=predictors\_knn[train,], test=predictors\_knn[-train,], cl=y[train], prob=TRUE, k=40)   
data.frame(y[-train],nearest10,nearest20, nearest40)

## y..train. nearest10 nearest20 nearest40  
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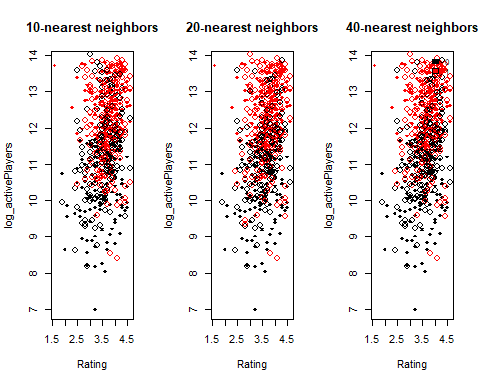
confusion\_matrix\_10 <- table(y[-train], nearest10)  
confusion\_matrix\_20 <- table(y[-train], nearest20)  
confusion\_matrix\_40 <- table(y[-train], nearest40)  
fp\_rate\_10 <- confusion\_matrix\_10[1,2] / sum(confusion\_matrix\_10[,2]) # False Positive Rate  
fn\_rate\_10 <- confusion\_matrix\_10[2,1] / sum(confusion\_matrix\_10[,1]) # False Negative Rate  
sensitivity\_10 <- confusion\_matrix\_10[2,2] / sum(confusion\_matrix\_10[2,]) # Sensitivity  
specificity\_10 <- confusion\_matrix\_10[1,1] / sum(confusion\_matrix\_10[1,]) # Specificity  
  
# Calculate performance metrics for k = 20  
fp\_rate\_20 <- confusion\_matrix\_20[1,2] / sum(confusion\_matrix\_20[,2]) # False Positive Rate  
fn\_rate\_20 <- confusion\_matrix\_20[2,1] / sum(confusion\_matrix\_20[,1]) # False Negative Rate  
sensitivity\_20 <- confusion\_matrix\_20[2,2] / sum(confusion\_matrix\_20[2,]) # Sensitivity  
specificity\_20 <- confusion\_matrix\_20[1,1] / sum(confusion\_matrix\_20[1,]) # Specificity  
  
# Calculate performance metrics for k = 40  
fp\_rate\_40 <- confusion\_matrix\_40[1,2] / sum(confusion\_matrix\_40[,2]) # False Positive Rate  
fn\_rate\_40 <- confusion\_matrix\_40[2,1] / sum(confusion\_matrix\_40[,1]) # False Negative Rate  
sensitivity\_40 <- confusion\_matrix\_40[2,2] / sum(confusion\_matrix\_40[2,]) # Sensitivity  
specificity\_40 <- confusion\_matrix\_40[1,1] / sum(confusion\_matrix\_40[1,]) # Specificity  
  
# Output the performance metrics  
results <- data.frame(  
 k = c(10, 20, 40),  
 fp\_rate = c(fp\_rate\_10, fp\_rate\_20, fp\_rate\_40),  
 fn\_rate = c(fn\_rate\_10, fn\_rate\_20, fn\_rate\_40),  
 sensitivity = c(sensitivity\_10, sensitivity\_20, sensitivity\_40),  
 specificity = c(specificity\_10, specificity\_20, specificity\_40)  
)  
  
print(results)

## k fp\_rate fn\_rate sensitivity specificity  
## 1 10 0.4318182 0.4189189 0.6172840 0.5308642  
## 2 20 0.4021739 0.3714286 0.6790123 0.5432099  
## 3 40 0.3757576 0.3710692 0.6358025 0.6172840

predictors\_knn <- as.data.frame(as.matrix(developer\_dummies))  
  
## Plot the three KNN models  
par(mfrow = c(1, 3))  
# Plot for 10/20/40-nearest neighbors  
plot(game[train, 'Rating'], predictors\_knn[train, 2], col = y[train], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "10-nearest neighbors")  
points(game[-train, 'Rating'], predictors\_knn[-train, 2], pch = 21, col = 1, cex = 1.25)  
points(game[-train, 'Rating'], predictors\_knn[-train, 2], bg = nearest10, pch = 21, col = grey(0.9), cex = 1.25)  
  
plot(game[train, 'Rating'], predictors\_knn[train, 2], col = y[train], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "20-nearest neighbors")  
points(game[-train, 'Rating'], predictors\_knn[-train, 2], pch = 21, col = 1, cex = 1.25)  
points(game[-train, 'Rating'], predictors\_knn[-train, 2], bg = nearest20, pch = 21, col = grey(0.9), cex = 1.25)  
  
plot(game[train, 'Rating'], predictors\_knn[train, 2], col = y[train], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "40-nearest neighbors")  
points(game[-train, 'Rating'], predictors\_knn[-train, 2], pch = 21, col = 1, cex = 1.25)   
points(game[-train, 'Rating'], predictors\_knn[-train, 2], bg = nearest40, pch = 21, col = grey(0.9), cex = 1.25)  
  
# Add legend  
legend("topright", legend = levels(y), fill = 1:2, bty = "n", cex = 0.75)



## Problematic  
# Plot the three KNN models  
par(mfrow = c(1, 3))  
  
# Define colors for plot  
colors <- c("black", "red")  
  
# Plot for 10-nearest neighbors  
plot(game$Rating[train], log(game$activePlayers[train]), col = colors[as.numeric(y[train])], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "10-nearest neighbors")  
points(game$Rating[-train], log(game$activePlayers[-train]), pch = 21, col = colors[as.numeric(nearest10)], cex = 1.25)  
  
# Plot for 20-nearest neighbors  
plot(game$Rating[train], log(game$activePlayers[train]), col = colors[as.numeric(y[train])], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "20-nearest neighbors")  
points(game$Rating[-train], log(game$activePlayers[-train]), pch = 21, col = colors[as.numeric(nearest20)], cex = 1.25)  
  
# Plot for 40-nearest neighbors  
plot(game$Rating[train], log(game$activePlayers[train]), col = colors[as.numeric(y[train])], cex = 0.8, pch = 18, xlab = "Rating", ylab = "log\_activePlayers", main = "40-nearest neighbors")  
points(game$Rating[-train], log(game$activePlayers[-train]), pch = 21, col = colors[as.numeric(nearest40)], cex = 1.25)  
  
# Add legend  
legend("topright", legend = c("0", "1"), fill = colors, bty = "n", cex = 0.75)



set.seed(1234)  
nearest <- class::knn(train=predictors\_knn[train,], test=predictors\_knn[-train,], cl=y[train], prob=TRUE, k=floor(40)) # sqrt(1735)  
attr<-attributes(nearest)  
t1 <- table(y[-train], nearest)  
t1

## nearest  
## 0 1  
## 0 85 77  
## 1 74 88

# Calculate relevant rates  
t1[1,2]/sum(t1[,2]) # FALSE POSITIVE RATE:

## [1] 0.4666667

t1[2,1]/sum(t1[,1]) # FALSE NEGATIVE RATE:

## [1] 0.4654088

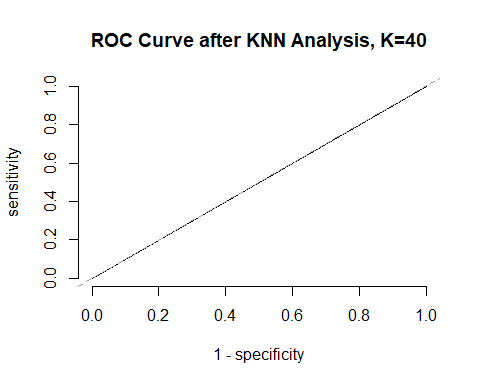
t1[2,2]/sum(t1[2,]) # SENSITIVITY:

## [1] 0.5432099

t1[1,1]/sum(t1[1,]) # SPECIFICITY:

## [1] 0.5246914

source("roc.R")  
roc(p= attr$prob, y=y[-train], bty="n")  
title("ROC Curve after KNN Analysis, K=40")



##   
probabilities <- attr$prob  
  
# Combine the test set indices with their probabilities  
test\_indices <- (1:nrow(game))[-train]  
prob\_data <- data.frame(index = test\_indices, probability = probabilities, nearest = nearest)  
  
# Sort by probability to get top 5 games  
top\_5k <- prob\_data %>%  
 arrange(desc(probability)) %>%  
 head(26)  
  
top\_5k

## index probability nearest  
## 1 1 0.5 1  
## 2 3 0.5 0  
## 3 5 0.5 0  
## 4 6 0.5 0  
## 5 8 0.5 0  
## 6 9 0.5 0  
## 7 10 0.5 1  
## 8 11 0.5 1  
## 9 13 0.5 0  
## 10 14 0.5 0  
## 11 17 0.5 0  
## 12 18 0.5 0  
## 13 19 0.5 1  
## 14 22 0.5 0  
## 15 29 0.5 1  
## 16 30 0.5 0  
## 17 32 0.5 1  
## 18 34 0.5 1  
## 19 36 0.5 1  
## 20 37 0.5 1  
## 21 38 0.5 1  
## 22 40 0.5 1  
## 23 41 0.5 1  
## 24 42 0.5 1  
## 25 43 0.5 1  
## 26 44 0.5 0

# Get the details of the top 5 games  
top\_5k\_games <- game[top\_5k$index, ]  
top\_5k\_games <- top\_5k\_games[top\_5k\_games$activePlayers\_dummy == 1, ]  
  
print(top\_5k\_games)

## Title  
## 1 13 Sentinels: Aegis Rim  
## 3 A Hat in Time  
## 5 A Way Out  
## 9 Alpha Protocol  
## 11 Among Us  
## 14 Animal Crossing: New Leaf  
## 17 Ape Out  
## 18 Apex Legends  
## 19 Armored Core 4  
## 29 Atomic Heart  
## 30 Attack of the Friday Monsters! A Tokyo Tale  
## 32 Baba is You  
## 34 Back to the Future: The Game  
## 36 Batman: Arkham City  
## 37 Batman: Arkham Knight  
## 38 Batman: Arkham Origins  
## 40 Battlefield 1  
## 41 Battlefield 4  
## 42 Battlefield: Bad Company 2  
## 43 Bayonetta  
## 44 Bayonetta 2  
## console publisher  
## 1 All PS4 NS PC Sega  
## 3 All PC OSX XOne PS4 Gears for Breakfast  
## 5 PS4 XOne PC All Series Electronic Arts  
## 9 PS3 X360 PC Sega  
## 11 XS XOne PS5 PS4 NS PC Unknown  
## 14 3DS Nintendo  
## 17 PC NS Unknown  
## 18 NS PS4 PC XOne Electronic Arts  
## 19 X360 PS3 Sega  
## 29 PS4 XS XOne PC Focus Home Interactive  
## 30 3DS Level 5  
## 32 NS Unknown  
## 34 PS4 PS3 Wii X360 XOne PC PSN Telltale Games  
## 36 PS3 X360 PC All Warner Bros. Interactive  
## 37 PS4 XOne PC All Warner Bros. Interactive  
## 38 PS3 X360 WiiU PC Warner Bros. Interactive Entertainment  
## 40 PS4 XOne PC All Electronic Arts  
## 41 PS4 PS3 X360 XOne PC Electronic Arts  
## 42 X360 PS3 PC All XBL Electronic Arts  
## 43 PS3 X360 Series All NS PC XBL WiiU Sega  
## 44 All NS WiiU Nintendo  
## developer genre total\_sales  
## 1 Vanillaware Adventure NA  
## 3 Gears for Breakfast Platform NA  
## 5 Hazelight Action NA  
## 9 Obsidian Entertainment Role-Playing 0.85  
## 11 Innersloth Party NA  
## 14 Nintendo EAD Simulation NA  
## 17 Gabe Cuzzillo Action NA  
## 18 Respawn Entertainment Shooter NA  
## 19 From Software Simulation 0.45  
## 29 Mundfish Shooter NA  
## 30 Millenium Kitchen Action-Adventure NA  
## 32 Unknown Adventure NA  
## 34 Telltale Games Adventure NA  
## 36 Rocksteady Studios Action NA  
## 37 Rocksteady Studios Action NA  
## 38 Warner Bros. Interactive Entertainment Action-Adventure NA  
## 40 EA DICE Shooter NA  
## 41 EA DICE Shooter 14.60  
## 42 EA Digital Illusions CE Shooter NA  
## 43 PlatinumGames Action NA  
## 44 PlatinumGames Action NA  
## Release.Date Genres Rating  
## 1 2019-11-28 ['Adventure', 'Simulator', 'Strategy', 'Tactical'] 4.4  
## 3 2017-10-05 ['Adventure', 'Indie', 'Platform'] 4.0  
## 5 2018-03-23 ['Adventure'] 3.6  
## 9 2010-05-28 ['RPG', 'Shooter'] 3.3  
## 11 2018-06-15 ['Indie', 'Strategy'] 3.0  
## 14 2012-11-08 ['Simulator'] 4.0  
## 17 2019-02-28 ['Adventure', 'Arcade', 'Fighting', 'Indie'] 3.5  
## 18 2019-02-04 ['Shooter'] 3.1  
## 19 2006-12-21 ['Fighting'] 3.7  
## 29 2023-02-21 ['Adventure', 'RPG', 'Shooter'] 3.0  
## 30 2013-07-17 ['Adventure', 'Simulator'] 3.7  
## 32 2019-03-13 ['Indie', 'Puzzle', 'Strategy'] 4.0  
## 34 2010-12-22 ['Adventure', 'Point-and-Click'] 3.2  
## 36 2011-10-18 ['Adventure', 'Brawler'] 4.1  
## 37 2015-06-23 ['Adventure', 'Brawler'] 3.7  
## 38 2013-10-16 ['Adventure', 'Brawler'] 3.4  
## 40 2016-10-21 ['Shooter'] 3.4  
## 41 2013-10-29 ['Shooter'] 3.5  
## 42 2010-03-02 ['Adventure', 'Shooter', 'Simulator', 'Strategy'] 3.6  
## 43 2009-10-29 ['Brawler', 'Shooter'] 3.9  
## 44 2014-09-20 ['Brawler'] 4.1  
## Times.Listed year Number.of.Reviews  
## 1 1.2K 2019 1200  
## 3 898 2017 898000  
## 5 620 2018 620000  
## 9 170 2010 170000  
## 11 867 2018 867000  
## 14 813 2012 813000  
## 17 329 2019 329000  
## 18 624 2019 624000  
## 19 92 2006 92000  
## 29 363 2023 363000  
## 30 178 2013 178000  
## 32 545 2019 545000  
## 34 94 2010 94000  
## 36 1.6K 2011 1600  
## 37 1.2K 2015 1200  
## 38 642 2013 642000  
## 40 513 2016 513000  
## 41 431 2013 431000  
## 42 288 2010 288000  
## 43 1.7K 2009 1700  
## 44 1.1K 2014 1100  
## Summary  
## 1 Uncover the truth and delve into a 2D sidescrolling adventure featuring gorgeous art and environments. Then, battle the kaiju in fast-paced, top-down combat. Customize the Sentinels with an arsenal of mechsuit weaponry, and fight to defend humanity!  
## 3 A Hat in Time is a cute-as-heck 3D platformer featuring a little girl who stitches hats for wicked powers! Freely explore giant worlds and recover Time Pieces to travel to new heights!  
## 5 From the creators of Brothers: A Tale of Two Sons comes A Way Out, an exclusively co-op adventure where you play the role of one of two prisoners making their daring escape from prison. What begins as a thrilling breakout quickly turns into an unpredictable, emotional adventure unlike anything seen or played before. A Way Out is an experience that must be played with two players. Each player controls one of the main characters, Leo and Vincent, in a reluctant alliance to break out of prison and gain their freedom.  
## 9 A talented young agent cast out by his government, Thorton is the only one with the information needed to stop an impending international catastrophe. To do so means he must cut himself off from the very people he is sworn to protect. As players determine how to accomplish different objectives, the decisions made and actions taken in each mission will ultimately transform the type of secret agent Michael Thorton will become. Every choice the player makes as Michael Thorton will carry consequences for his future and the fate of the world.  
## 11 Join your crew-mates in a multiplayer game of teamwork and betrayal! Play with 4-15 players online or via local WiFi as you attempt to prepare your spaceship for departure, but beware as one or more random players among the Crew are Impostors bent on killing everyone!  
## 14 The charming community-building franchise returns for with Animal Crossing: New Leaf. The Nintendo 3DS entry into this popular franchise introduces a number of options new to Animal Crossing, including the ability to become the head of the village and boost its development, a way to install certain items in the village to make its characteristics more personalized for each player, and the ability to view homes of other players who are tagged through StreetPass connections.  
## 17 Ape Out is a wildly intense and colorfully stylized smash ���������em up about primal escape, rhythmic violence, and frenetic jazz. Build up nearly unstoppable momentum and use your captors as both weapons and shields to crush everyone on your procedurally ge  
## 18 Conquer with character in Apex Legends, a free-to-play Hero shooter where legendary characters with powerful abilities team up to battle for fame & fortune on the fringes of the Frontier.\n \n\n Master an ever-growing roster of diverse Legends, deep tactical squad play and bold new innovations that go beyond the Battle Royale experience���������all within a rugged world where anything goes. Welcome to the next ev  
## 19 Armored Core, the mech action game that defined the mech genre is back to take on next-generation platforms! Armored Core 4 reinvigorates the brand by offering an all-new storyline, new environments, and online capability. The 10th anniversary of the acclaimed franchise is punctuated with a leap to next-generation platforms that will ensure a new quality level in both gameplay and visual performance.  
## 29 Atomic Heart is an adventure first-person shooter, events of which unfolds in an alternate universe during the high noon of the Soviet Union. The principal character of the game is a special agent P-3, who after an unsuccessful landing on enterprise "3826" is trying to figure out what went wrong.  
## 30 Step into the life of Sohta, the young son of a family that has just set up a dry cleaners shop in the idyllic town of Fuji no Hana. In his interactions with the town's unique residents, episodic mysteries are revealed that portend to the strange events surrounding the appearance of a giant monster every Friday. And finally, when Friday evening falls, the giant monster will appear right before your eyes!\n \n\n Collect the "Monster Glims" scattered around town to form Monster Cards, and once you've collected five cards, Sohta can battle his friends for dominance. Winning at Monster Cards gives you the chance to collect useful information, more Monster Glims, and even to cast a secret spell on your friends that will make them fall down at your whim. Why? Because that's the rules!\n \n\n A touching drama about family, friendship, and the innocence of being a child unfolds against hand-drawn backgrounds, charming music, and memorable characters.  
## 32 Baba Is You is a puzzle game where you can change the rules by which you play. In every level, the rules themselves are present as blocks you can interact with; by manipulating them, you can change how the level works and cause surprising, unexpected interactions! With some simple block-pushing you can turn yourself into a rock, turn patches of grass into dangerously hot obstacles, and even change the goal you need to reach to something entirely different.  
## 34 Back to the Future: The Game is one of Telltale Games' popular episodic games. It follows the story of the famous Marty McFly and Doc Brown as they stumble through another adventure in time. It is broken into 5 episodes, and incorporates Telltale's unique spin on point-and-click games.  
## 36 After the events of Batman: Arkham Asylum (2009), a section of the city of Gotham has been turned into a prison, designed to keep the scum of the city away from the people. Bruce Wayne protests this prison but is shortly kidnapped by the despicable Hugo Strange, thus having to face the city's most powerful villains as the Batman while trying to uncover Strange's plans.  
## 37 Batman: Arkham Knight brings the award-winning Arkham trilogy from Rocksteady Studios to its epic conclusion. Developed exclusively for New-Gen platforms, Batman: Arkham Knight introduces Rocksteady's uniquely designed version of the Batmobile. The highly anticipated addition of this legendary vehicle, combined with the acclaimed gameplay of the Arkham series, offers gamers the ultimate and complete Batman experience as they tear through the streets and soar across the skyline of the entirety of Gotham City. In this explosive finale, Batman faces the ultimate threat against the city that he is sworn to protect, as Scarecrow returns to unite the super criminals of Gotham and destroy the Batman forever.  
## 38 Batman: Arkham Origins features an expanded Gotham City and introduces an original prequel storyline occurring several years before the events of Batman: Arkham Asylum and Batman: Arkham City.  
## 40 Discover classic Battlefield gameplay with epic multiplayer and an adventure-filled campaign. Experience the dawn of all-out war, only in Battlefield 1. Fight your way through epic battles going from tight urban combat in a besieged French city to big open spaces in the Italian Alps or frantic combats in the Arabic sand dunes. Experience large-scale battles as infantry or piloting vehicles on land, air and sea, from the tanks and bikes on the ground, to bi-planes and gigantic battleships.  
## 41 Battlefield 4 is the genre-defining action blockbuster created by Dice, and made from moments that blur the line between game and glory, moments found only in Battlefield. Go to Boot Camp to learn the basics of Battlefield 4's engaging single player and intense multiplayer mode. Here you'll also find intel on Levolution, Commander Mode, Naval Warfare and many more exciting game features.  
## 42 Battlefield: Bad Company 2 brings the award-winning Battlefield gameplay to the forefront of PC gaming with best-in-class vehicular combat and unexpected "Battlefield moments."\n \n\n New vehicles like the ATV and a transport helicopter allow for all-new multiplayer tactics on the Battlefield. With the Frostbite-enabled Destruction 2.0 system, you can take down entire buildings and create your own fire points by blasting holes through cover. You can also compete in four-player teams in two squad-only game modes, fighting together to unlock exclusive awards and achievements.\n \n\n Battles are set across expansive maps, each with a different tactical focus. The game also sees the return of the B Company squad in a more mature single-player campaign.  
## 43 A member of an ancient witch clan and possessing powers beyond the comprehension of mere mortals, Bayonetta faces-off against countless angelic enemies, many reaching epic proportions, in a game of 100% pure, unadulterated all-out action. Outlandish finishing moves are performed with balletic grace as Bayonetta flows from one fight to another. With magnificent over-the-top action taking place in stages that are a veritable theme park of exciting attractions, Bayonetta pushes the limits of the action genre, bringing to life its fast-paced, dynamic climax combat.  
## 44 The witching hour strikes again. Brimming with intricate battles that take place in, on and all over epic set pieces, Bayonetta 2 finds our sassy heroine battling angels and demons in unearthly beautiful HD. You���������re bound to love how it feels to string together combos with unimaginable weapons and to summon demons using Bayonetta���������s Um  
## Reviews  
## 1 ['A visual novel combined with strategy/tower defense gameplay.\\n \\n It was good, but the replay value is rather limited.', 'This has become my favorite visual novel storyline and possibly top 15 storyline in general. I love sci fi stories than can creat elaborate worlds like this. I do wish the gameplay was more interesting tho.', "it is not perfect - it's a bit too heterosexual and there are parts of the ending i have issues with - but tiny itty bitty little issues like that just do not matter in the face of one of the greatest narrative experiences I have ever experienced. This is seriously a revolution in interactive storytelling and if you have even the slightest interest in it then you should play it as soon as possible. Its especially an absolute treat for anyone who loves to think about how game design can influence and bolster the narrative games try to convey", 'I love video games so fucking much', "This wasn't for me; it wasn't to my taste, unfortunately. I got out of the tutorial to the mode select and put it down.", "peak fiction, one of the best artstyles I've ever seen in a modern game"]  
## 3 ["It didn't really interest me and I got bored fast, played poorly on my Nintendo Switch as well.", 'Bem foda', 'A hat in time has the same flaws of other 3d platformers like conkers bad fur day and psychonaughts where the focus is on the characters and story and less on the platforming.', 'A very charming and silly game. It has lots of really fun platforming moments, and the level theming is great. I hope this game gets a sequel of some kind, or the studio makes another 3D platformer. They really did well with this game, and I give it a recommendation', '"A Hat in Time" ������ um jogo Indie desenvolvido pela Gears for Breakfast e lan������ado em 2017. O jogo apresenta uma garotinha chamada Hat Kid que viaja por v������rios mundos para coletar Ampulhetas para consertar sua Nave espacial\\n \\n O Jogo ������ muito bonitinho, tendo personagens charmosos, ambientes coloridos e m������sicas envolventes. Baseado em Jogos Coletaton do Final dos anos 90 como Mario 64 e Banjo-Kazooie, o jogo herda deles uma gameplay precisa al������m de um charme imut������vel, com diversos mundos diferentes para explorar, indo de uma cidade na praia para uma mans������o assombrada com uma princesa assustadora,(que ainda me d������ medo)\\n \\n A Hat in time ������ um banho de nostalgia para qualquer pessoa que cresceu na quarta e quinta gera������������o de consoles , at��� b \\n As DLCs parecem ser mais do mesmo , uma expans������o do gameplay sem adicionar nada de muito novo , que se for seguir o n������vel de polimento que o jogo principal tem ja vi que elas ser������o ������timas , mas at������ agora ainda n������o tive tempo para jogar elas\\n \\n No geral , A Hat in Time, ������ um jogo fant������stico , um jogo indie que captura perfeitamente do charme dos jogos de Gamecube e Nintendo 64 ao mesmo tempo em que adiciona seu toque ������nico. Com seu"I finished it! I still don't like platformers! Yay!"]  
## 5 ['FAKAYOU VINCENT !', 'Never worked as hard in my live as i did when i was arm wrestling with my friend in this game.', 'forgot to log', 'Another great tale of two brothers from Josef Fares. The story is pretty barebones and unspecial throughout but it���������s all tied together with a pretty great and unforeseen conclusion. The two main characters are really nice, having sort of a True Detective-protag style bond that sees you slowly care for each other more as the chaos intensifies. Gameplay widely varies from small minigames to stealth sections to QTE-mania to full-on cover shooter, like a more scatterbrained version of A Plague Tale which wouldn���������t come out for another year. As scatterbrained as it seems, it still all comes together to create a pretty semi-unique experience. The aesthetic of the game is also pretty good, feeling like an anachronistic mashup of the 1970s and modern day, until you find out for sure that it���������s the 1970s.', Pros: good story,characters, choices, gameplay']  
## 9 ['I think if Alpha Protocol had good gameplay it would be immediately a lot better, still have a lot of issues with the storytelling and how impressively offensive the game can be both intentionally and unintentionally', 'If the bugs were not there and the game worked as intended , the game would be solid . The only thing the sequel if it were to happen would need if the bugs were fixed would be to be a longer game , better thorton dialogue , better gameplay and to have an art style. Overall, This broken and flawed game is better than 100% of modern games .', 'H\*rny cia game', "The most alienating part about the Mass Effect games is the way they're consistently written as though their fascistic manboy protagonist were charming or at least normal. Obsidian makes this game substantially more playable by writing Mike Thorton as consistently weird and unpersonable. Rather than cultivating a sense of identification with the player, which by convention we still call role-playing, the dialogue options presage Deltarune and feel like steering a man who desperately wants to sabotage his own life down a narrow path of relative normalcy.", 'Gostoso de jogar qnem um filme de a������������o bem "If you play it on easy it's amazing. Definitely doing a second run as soon as possible"]  
## 11 ["it's a solid party game. i'm bad at lying though and it makes me feel bad; not a complaint with the game, it's a complaint with myself that makes it harder for me personally to enjoy", '��������� amogus', 'lie to your friends simulator', 'Amogus', 'I vote we just shoot Wawa into space and see what happens.', 'ya, i beat a  
## 14 ['I spent 3 hours restarting my file until I got a map that allowed me to build my house on an island with a small land bridge connecting to the mainland.', "You're fun and cute and I like you.", 'I still feel like crying when I hear the 7 pm theme. I want to go back to the days of meeting random people online while catching bugs and sharks on kapp���������ns island', 'nostalgic! best animal crossing game', 'Soooo nostalgic :,) I still pick it up every once in a while and end up getting sucked into it for a whole week\\n \\n When I was like 10 Goldie left my town and I cried so hard I vomited. My mom comforted me at the time by telling me I had my siblings and\\n \\n real\\n \\n friends but WHO GAF ABOUT THEM I WANTED GOLDIE!!! Anyway I reminded her of it the other day and she told me ���������you cried more then than when your parents got seperated.���������', 'i love this game; best source of comfort and, now, nostalgia from the 3ds\\n \\n also the ost slaps\\n \\n   
## 17 ['Dank Harambe Memes compilation You laugh You lose V27', 'just loads of raw, animalistic fun. managed to raise my adrenaline quite a lot and always kept me in a very intensified and excited mood, and the way the music interplays with your actions is awesome. something about throwing a bunch of guys at walls as a rabid gorilla is ridiculously satisfying, and this has such a good sense of game juice which raises that satisfaction level up to eleven', 'Rating: 7.3/10 Good', 'Fucking realistic. I went ape shit while playing this.\\n \\n 8/10', 'very interesting in music,art style and gameplay,cool game', 'A ideia ������ bem inteligente. Misturar uma jogabilidade simples, mas frustrante (no bom sentido) com uma trilha sonora espetacular e visuais lindos tornaram minha experi������ncia bem divertida. Mais um bom jogo distribu���  
## 18 ['te odio', 'Boring and shite.', "One of the best battle Royal games...but the developers of the Company don't give a single fuck os what s happening with the game. Such a poor administration of the game, but It Still, an incredible and enjoyable game.\\n \\n 8", 'Apex is just a better Fortnite, Warface, Warframe, Destiny, etc lmfao, I think it is really balanced and a very fun game. I would recommend this to anyone who wants to try FPS games, and developed by EA! Surprising considering they ruin franchises most of the time hehe.', 'This game is exceedingly obnoxious', 'Only acceptable battle royale, and even then it���������s only solid. Gunplay   
## 19 ["First of all I'm really happy that this game emulates so well, I'm extremely impressed by PS3 emulation and I'm only hoping every AC game onwards emulates as well.\\n \\n Now, onto the game.\\n \\n Well, the best way to describe it is that it's different, very different.\\n \\n Overall gameplay has changed extremely drastically; your AC is much faster, areas are MUCH bigger, and boosting now doesn't even take your energy unless you're flying. The older games are much more strategic in what you needed to use and how to do it, this one is very straightforward instead. This does lead to balance that is clearly towards light ACs, no matter what I did I could never make a quad AC work as well as my simple super lightweight AC, specially since heavy weapons, such as the back cannon, have very heavy recoil that stops you on your tracks, and not moving 24/7 like it's fucking Doom Eternal is an objectively bad strategy. There's also a lot less parts than the previous installments, for example there's only around 6 heavy back weapons, 2 quad legs and 2 tank threads. Nonetheless, I can excuse some of these changes as the game is very different from previous installments like I mentioned. Even the plot is different, having less of a feel towards being a simple mercenary and more of being a heroic soldier.\\n \\n Overall, it is an interesting take on the series, and I do wonder what will For Answer be like.", 'Armored Core 4 is a very interesting title. Starting with this iteration the franchise took a radical departure from the slower more methodical gameplay of the previous entries in favor of a much faster pace and more streamlined mechanics. In some instances it works incredibly well and in others it feels like a case of one step forward two steps back.', "Give me your White Glint, bitch.\\n \\n You're not using it anymore.", '"Let\\'s confirm the mission."', "Armored Core 4 is a radical departure from the previous games in both the way the game is played and presented especially with Miyazaki on his debut as the director. While customization isn't as deep as before, missions are short and the environments feel like a step behind, the moment-to-moment gameplay is really fun and felt like a step in the right direction as the series moved to a new generation. The satisfaction of completing a level is also complemented to the story, more notably the player mercenary/operator relationship developing as you finish each mission. The story was also nice and had some signs of greatness, but I feel like it could have elevated to something better if not for a few missteps. The soundtrack bangs as expected from an AC game. Definitely recommend this one and it also runs well on an emulator.", 'too short, too easy, and basically more minor for the answer.\\n \\n Emulator crashes']  
## 29 ['ana karakter keko', '>"I\\'m sick to death of shoving balls into tubes."', 'where is sex', "Pretty solid Bioshock like with a Soviet twist. The story and the gameplay take a while to get going, but by the end of it you can't stop playing.", 'Oh gosh, I don���������t know where even to start. Yes, yes, this is a disaster in terms of the performance, quality of"Commits certain design sins that maybe 2 to 3 years ago I wouldn't have noticed but now make me groan. I'm evolving. I don't put up with games like this anymore. I have a girlfriend to feed."]  
## 30 ['y���������all ever watch tim rogers weirdo freak boku no video where he comes off looking like a failson weeaboo orientalist���������.I do not like this game lol', 'play this game play this game play this game play this game play this game play this game play this game play this game play this game', 'Charming lil game.', 'sweet little game that made me remember all the random rules in games that kids come up with', 'It���������s pretty good. Also very strange and short.', 'Sweet as sugar.\\n \\n Sweet as you  
## 32 ['peak puzzle game that i cant beat because i am bad', 'I really like the game, but every time I play I get frustrated cause I\\'m bad at it. I want to finish it at some point though, and I think it\\'s an "easy" game to get back to', 'i wish i was smart enough to beat this game :(', "100% unique block pushing game. First time I've ever been asked to solve a level select screen.", 'one of the best puzzle games of all time for sure', "I enjoy Baba is You conceptually but it can be challenging to a fault. Sometimes it feels like the game is more interested in stumping the player than helping the player succeed. I'm sure this appeals to some players, but it can become frustrating when you get really stuck. A cool game, but it requires a lot of patience."]  
## 34 ['Very enjoyable game. The story adds onto the movies without ruining anything from them. The gameplay is also pretty cool and fun, the puzzles are challenging but not annoying.', 'i need to give this another try', 'When I was little I was obsessed with Back to the Future and then I found this game on my iPad. I played it all the time and I made my dad buy all the episodes. I didn���������t even really know much in english so I was always asking my dad what this and that means lol. Poor dad. I don���������t remember much of the episodes except for the first one so I can���������t really give the game a rating. Anyways I really love this "Probably the closest we'll ever get to BTTF 4 but honestly they pulled it off.", 'F������r mich der inoffizielle vierte Teil der Reihe. Klar, die Puzzles dieses Point and Click Adventures von Telltale sind super einfach, aber ich bin hier wegen der Story und die wurde in meinen Augen gelungen weitergef������hrt. Ein Trumpf ist auch, dass Christopher Lloyd als Doc Brown zur������ckkehrt und die englische Stimme von Marty unfassbar nah an Michael J. Fox ist. Wer die Filme liebt, kann hier eigentlich kaum etwas falsch machen. Spannend, toll geschrieben, mit viel Humor und dem Herz am rechten Fleck. Ein Muss f������r alle, die sich einen vierten Teil w������nschen, aber "Probably the closest we'll get to a good Back to the Future 4 and I'm fine with that."]  
## 36 ['My mom never let me play video games during the week. So, as a kid, coming home from school on a Friday was a big deal. I really never saved my money for video games at the time, so I essentially played this game for 2 years constantly. The free roaming is great, the story is engaging and experimental. Even though there are issues with bugs, it still is an incredible game that I think everybody should play.', 'Ap������s os eventos de Arkham Asylum, Hugo Strange junto de Quincy Sharp abrem uma pris������o em uma regi�"Arkham City", Bruce fica incomodado e decide lutar contra a pris������o politicamente, a TIGER(soldados de Strange) capturam Wayne e Hugo revela a Bruce que sabe o maior segredo dele, Bruce Wayne ������ o Batman, Hugo n������o conta a ningu������m ainda mas j������ deixa avisado que caso tente fazer algo contra seus planos, ele ir������ revelar esse segredo, e ������ aqui que n������s come������amos o jogo.\\n \\n A hist������ria de City ������ perfeita do come������o ao fim, os personagens s������o excelentes e muito carism������ticos.\\n \\n O gameplay comparado ao seu antecessor ������ uma grande evolu������������o, nem parecem o mesmo jogo, Asylum ������ muito lento comparado a City, o Batman neste jogo esta mais �����. m o jogo anterior, Senhor Frio ������ o melhor chefe de toda a franquia arkham.\\n \\n Um ponto negativo desse jogo s������o as miss������es secund������rias, apesar de algumas bacanas, muito delas s������o entediantes e chatas de se fazer, um exemplo disso ������ a dos pol������ticos, ������ legal para a lore do jogo? Sim! ������ legal para o gameplay? N������o, mas isto n������o ������ um grande problema que acaba com a sua experi������ncia. O melhor jogo do Batman j����"I\\'m literally him".', "The nice thing about this game is it's open-world but small enough that getting around isn't a chore."] ['My mom never let me play video games during the week. So, as a kid, coming home from school on a Friday was a big deal. I really never saved my money for video games at the time, so I essentially played this game for 2 years constantly. The free roaming is great, the story is engaging and experimental. Even though there are issues with bugs, it still is an incredible game that I think everybody should play.', 'Ap������s os eventos de Arkham Asylum, Hugo Strange junto de Quincy Sharp abrem uma pris������o em uma regi�"Arkham City", Bruce fica incomodado e decide lutar contra a pris������o politicamente, a TIGER(soldados de Strange) capturam Wayne e Hugo revela a Bruce que sabe o maior segredo dele, Bruce Wayne ������ o Batman, Hugo n������o conta a ningu������m ainda mas j������ deixa avisado que caso tente fazer algo contra seus planos, ele ir������ revelar esse segredo, e ������ aqui que n������s come������amos o jogo.\\n \\n A hist������ria de City ������ perfeita do come������o ao fim, os personagens s������o excelentes e muito carism������ticos.\\n \\n O gameplay comparado ao seu antecessor ������ uma grande evolu������������o, nem parecem o mesmo jogo, Asylum ������ muito lento comparado a City, o Batman neste jogo esta mais �����t m o jogo anterior, Senhor Frio ������ o melhor chefe de toda a franquia arkham.\\n \\n Um ponto negativo desse jogo s������o as miss������es secund������rias, apesar de algumas bacanas, muito delas s������o entediantes e chatas de se fazer, um exemplo disso ������ a dos pol������ticos, ������ legal para a lore do jogo? Sim! ������ legal para o gameplay? N������o, mas isto n������o ������ um grande problema que acaba com a sua experi������ncia. O melhor jogo do Batman j����"I\\'m literally him".', "The nice thing about this game is it's open-world but small enough that getting around isn't a chore."]  
## 37 ['Has problems but i still like it a lot.', "Great UI, beautiful graphics, high quality voice-acting that the franchise is known for, and the biggest world map with incredible attention to detail, condensed with so much Batman history that it feels like the most complete love letter to the Batman mythos yet. An interesting reimagining of one of Batman's well-known stories.", 'This makes you feel like Batman', 'This game is too much of everything for its own good. I do not recommend it.', 'more cowbell less batmobile', 'FOOODAAAAAAAAAAAA']  
## 38 ["Weird that the studio made gotham knights instead of trying to make another arkham game like this. This is good! Yeah it launched kinda fucked up, but it's good now!", 'Really makes you feel like Batman.', "Sure it's not a masterpiece but definitely worth your time if you're into the Arkham Games. Still not entirely sure why the game got so much flak when it first came out. Still holds up great today though. Great boss fights.", "Aslyum'dan ������nce bu oyunu oynad������m\\n \\n Oynan������������������ gayet g������zel boss'lar������ di������er oyunlara g������re iyi ki Batman evreninde karakterlerin belli bir g������zelli������i var.\\n \\n ������l������nce gelen konu��\xef", 'Is nobody going to talk about how fun the multiplayer in this game was?', 'Much better than most reviews at the time would have you belive, the Christmas setting was a master stroke and the boss fights were pretty fire.']  
## 40 ['Stellar art direction and fun weapons. Held back on lack of actual sandbox gameplay that the franchise should embrace but also understandable as world war 1 is hard to explore without being a bit more grounded.', 'puan sadece hikaye modu i������in', 'like my bf4 review, another case of a game being REALLY fun 6-7 years ago when it released (like 4 stars), but nowadays on steam servers it���������s really not fun. looks cool and feels cinematic, but everyone says that. rather play bf4.', 'Fantastic graphics and sound design even all these years later. Format of shorter stories dotted around makes it difficult to be drawn"As a player, I found Battlefield 1 to be a thrilling first-person shooter game set during World War I. The game's attention to detail in weapons, equipment, environments, and landscapes creates an immersive atmosphere that draws players into the world of the game. The stunning visuals and realistic lighting effects further enhance the game's overall appeal, making it a visual treat.", 'genuinely attempting to play battlefield 1 over the several years it was the most current battlefield game felt like at best I was playing a different game from everyone I talked to about it and at worst that I was being gaslit about the game itself, genuinely unfun experience both in and out of game']  
## 41 ['This is a clear example of less is sometimes more. Battlefield 4 is an unbalanced mess of a game compared to 3. The scale is impressive but at the cost of player experience its not worth it.', 'Really bad campaign', 'i hate hate hate hate hate vehicle players, but it���������s battlefield and playing on normal tdm servers is even more of a hectic mess.\\n \\n this game 8-9 years ago = 4 stars and pretty dang awesome\\n \\n this game nowadays on steam servers = kinda rough and sweaty and players are annoying so i���������ll generously rate it 3 stars "My personal favorite battlefield game. I absolutely love the multiplayer in this game. The servers are still relatively active, even compared to some of their more recent releases (Battlefield 1, I'm sure Battlefield hardline falls into this same boat). Would highly recommend giving this game's multiplayer a shot if you have not done so already.", 'The only thing I remember about this game is that it had Michael Kenneth Williams for some reason. I don���������t even know why I own it. I���������m pretty sure I played like 2 hours of t  
## 42 ['Solid map design and a focus on linear gameplay surprisingly mixes well with battlefield. even though destruction can end up ruining the map design in areas it doesnt get old abusing it for kills.', 'The definition of fun.', 'The maps were huge towns with plenty of buildings which showed off the impressive destruction capabilities which modern day games (including newer battlefields) have shied away from.', "Had a blast with the multiplayer while it lasted, unfortunately the servers are no longer active. However, this game's singleplayer is worth it alone. It's not the most unique in terms of story or anything, but the character are so lovable and relatable. They even have dialog if they are left idle, and it is worth sitting around listening to these guys talk about whatever nonsense they are talking about. Highly recommend a few playthroughs of this one.", 'The best Battlefield game. Really could use a remaster or remake.', "Don't even like it as much as 3, but what I gotta give it is that there is no delay in gameplay making it the most arcade game in the series. 2,5/5"]  
## 43 ['Great but I hate the cheap one hit kill QTEs. Very pronounced lack of enemy variety that gets amended in later titles in the series', "Beat'em all at its best, with weird and frankly off putting enemy design.", 'I know this is really good but every time I see a combo list in a video game my head fills with static', 'at this point i lost the count of how many times i played this game', 'eu te amo hideki kamiya', 'https://www.amazon.com/gp/product/B08RMCZJ9K?psc=1']  
## 44 ['I prefer the first games story a smidge more, but the gameplay is just as good, if not better than the previous', 'Best of the trilogy', 'Shes back and shes badass. Literally slaying with her new haircut. Girlboss with guns. 5/5', 'Bayonetta but more fun, AND she has short hair now. Awesome.', 'Excellent story with less good gameplay than the first one. Still a very solid game overall.', 'The gameplay is slightly less good than the first game, but the way better story and direction make this game surpass it.']  
## Plays Playing Backlogs Wishlist atvi\_indi activePlayers allPlayers year\_adj  
## 1 3700 466000 3300 2500 0 469700 473000 19  
## 3 7200 320000 2700 1600 0 327200 329900 17  
## 5 6400 127000 945000 668000 0 133400 1078400 18  
## 9 987000 9000 511000 182000 0 996000 1507000 10  
## 11 25000 470000 776000 126000 0 495000 1271000 18  
## 14 9900 156000 586000 383000 0 165900 751900 12  
## 17 1800 46000 697000 324000 0 47800 744800 19  
## 18 12000 669000 463000 82000 0 681000 1144000 19  
## 19 252000 15000 232000 162000 0 267000 499000 6  
## 29 983000 241000 676000 1100 0 1224000 1900000 23  
## 30 393000 22000 385000 298000 0 415000 800000 13  
## 32 4600 537000 2000 1200 0 541600 543600 19  
## 34 763000 5000 223000 67000 0 768000 991000 10  
## 36 16000 192000 2700 651000 0 208000 210700 11  
## 37 13000 279000 3400 757000 0 292000 295400 15  
## 38 7800 125000 1700 632000 0 132800 134500 13  
## 40 7200 108000 741000 150000 0 115200 856200 16  
## 41 7100 72000 506000 124000 0 79100 585100 13  
## 42 4200 23000 349000 119000 0 27200 376200 10  
## 43 13000 614000 5000 2300 0 627000 632000 9  
## 44 6000 154000 3300 2000 0 160000 163300 14  
## log\_activePlayers log\_allPlayers activePlayers\_dummy  
## 1 13.05985 13.06685 1  
## 3 12.69833 12.70655 1  
## 5 11.80111 13.89099 1  
## 9 13.81150 14.22563 1  
## 11 13.11232 14.05532 1  
## 14 12.01915 13.53036 1  
## 17 10.77480 13.52087 1  
## 18 13.43132 13.95004 1  
## 19 12.49501 13.12036 1  
## 29 14.01764 14.45736 1  
## 30 12.93604 13.59237 1  
## 32 13.20228 13.20597 1  
## 34 13.55155 13.80647 1  
## 36 12.24530 12.25820 1  
## 37 12.58451 12.59609 1  
## 38 11.79661 11.80933 1  
## 40 11.65443 13.66026 1  
## 41 11.27848 13.27954 1  
## 42 10.21101 12.83788 1  
## 43 13.34870 13.35665 1  
## 44 11.98294 12.00335 1  
## Summary\_clean  
## 1 uncover truth delve into 2d sidescrolling adventure featuring gorgeous art environments then battle kaiju fast paced top down combat customize sentinels arsenal mechsuit weaponry fight defend humanity  
## 3 hat time cute heck 3d platformer featuring little girl stitches hats wicked powers freely explore giant worlds recover time pieces travel new heights  
## 5 creators brothers tale two sons comes way exclusively co op adventure play role one two prisoners making daring escape prison what begins thrilling breakout quickly turns into unpredictable emotional adventure unlike anything seen played before way experience must played two players each player controls one main characters leo vincent reluctant alliance break prison gain freedom  
## 9 talented young agent cast government thorton only one information needed stop impending international catastrophe do means must cut himself off very people sworn protect players determine how accomplish different objectives decisions made actions taken each mission ultimately transform type secret agent michael thorton become every choice player makes michael thorton carry consequences future fate world  
## 11 join crew mates multiplayer game teamwork betrayal play 4 15 players online via local wifi attempt prepare spaceship departure beware one more random players among crew impostors bent killing everyone  
## 14 charming community building franchise returns animal crossing new leaf nintendo 3ds entry into popular franchise introduces number options new animal crossing including ability become head village boost development way install certain items village make characteristics more personalized each player ability view homes other players tagged through streetpass connections  
## 17 ape wildly intense colorfully stylized smash ���������em about primal escape rhythmic violence frenetic jazz build nearly unstoppable momentum use captors both weapons shields crush everyone procedurally ge  
## 18 conquer character apex legends free play hero shooter legendary characters powerful abilities team battle fame fortune fringes frontier master ever growing roster diverse legends deep tactical squad play bold new innovations go beyond battle royale experience���������all within rugged world anything goes welcome next ev  
## 19 armored core mech action game defined mech genre back take next generation platforms armored core 4 reinvigorates brand offering new storyline new environments online capability 10th anniversary acclaimed franchise punctuated leap next generation platforms ensure new quality level both gameplay visual performance  
## 29 atomic heart adventure first person shooter events unfolds alternate universe during high noon soviet union principal character game special agent p 3 after unsuccessful landing enterprise 3826 trying figure what went wrong  
## 30 step into life sohta young son family just set dry cleaners shop idyllic town fuji no hana interactions town unique residents episodic mysteries revealed portend strange events surrounding appearance giant monster every friday finally when friday evening falls giant monster appear right before eyes collect monster glims scattered around town form monster cards once ve collected five cards sohta battle friends dominance winning at monster cards gives chance collect useful information more monster glims even cast secret spell friends make them fall down at whim why because rules touching drama about family friendship innocence being child unfolds against hand drawn backgrounds charming music memorable characters  
## 32 baba puzzle game change rules play every level rules themselves present blocks interact manipulating them change how level works cause surprising unexpected interactions some simple block pushing turn yourself into rock turn patches grass into dangerously hot obstacles even change goal need reach something entirely different  
## 34 back future game one telltale games popular episodic games follows story famous marty mcfly doc brown stumble through another adventure time broken into 5 episodes incorporates telltale unique spin point click games  
## 36 after events batman arkham asylum 2009 section city gotham been turned into prison designed keep scum city away people bruce wayne protests prison shortly kidnapped despicable hugo strange thus having face city most powerful villains batman while trying uncover strange plans  
## 37 batman arkham knight brings award winning arkham trilogy rocksteady studios epic conclusion developed exclusively new gen platforms batman arkham knight introduces rocksteady uniquely designed version batmobile highly anticipated addition legendary vehicle combined acclaimed gameplay arkham series offers gamers ultimate complete batman experience tear through streets soar across skyline entirety gotham city explosive finale batman faces ultimate threat against city sworn protect scarecrow returns unite super criminals gotham destroy batman forever  
## 38 batman arkham origins features expanded gotham city introduces original prequel storyline occurring several years before events batman arkham asylum batman arkham city  
## 40 discover classic battlefield gameplay epic multiplayer adventure filled campaign experience dawn war only battlefield 1 fight way through epic battles going tight urban combat besieged french city big open spaces italian alps frantic combats arabic sand dunes experience large scale battles infantry piloting vehicles land air sea tanks bikes ground bi planes gigantic battleships  
## 41 battlefield 4 genre defining action blockbuster created dice made moments blur line between game glory moments found only battlefield go boot camp learn basics battlefield 4 engaging single player intense multiplayer mode here find intel levolution commander mode naval warfare many more exciting game features  
## 42 battlefield bad company 2 brings award winning battlefield gameplay forefront pc gaming best class vehicular combat unexpected battlefield moments new vehicles like atv transport helicopter allow new multiplayer tactics battlefield frostbite enabled destruction 2 0 system take down entire buildings create own fire points blasting holes through cover compete four player teams two squad only game modes fighting together unlock exclusive awards achievements battles set across expansive maps each different tactical focus game sees return b company squad more mature single player campaign  
## 43 member ancient witch clan possessing powers beyond comprehension mere mortals bayonetta faces off against countless angelic enemies many reaching epic proportions game 100 pure unadulterated action outlandish finishing moves performed balletic grace bayonetta flows one fight another magnificent over top action taking place stages veritable theme park exciting attractions bayonetta pushes limits action genre bringing life fast paced dynamic climax combat  
## 44 witching hour strikes again brimming intricate battles take place over epic set pieces bayonetta 2 finds our sassy heroine battling angels demons unearthly beautiful hd you���������re bound love how feels string together combos unimaginable weapons summon demons using bayonetta���������s um  
## series Count IP\_Type activePlayersGroup  
## 1 13 Sentinels: 1 Not IP High  
## 3 A Hat 1 Not IP High  
## 5 A Way 1 Not IP Medium  
## 9 Alpha Protocol 1 Not IP High  
## 11 Among Us 1 Not IP High  
## 14 Animal Crossing: 3 Small IP Medium  
## 17 Ape Out 1 Not IP Low  
## 18 Apex Legends 1 Not IP High  
## 19 Armored Core 1 Not IP High  
## 29 Atomic Heart 1 Not IP High  
## 30 Attack of 1 Not IP High  
## 32 Baba is 1 Not IP High  
## 34 Back to 1 Not IP High  
## 36 Batman: Arkham 2 Small IP High  
## 37 Batman: Arkham 2 Small IP High  
## 38 Batman: Arkham 1 Not IP Medium  
## 40 Battlefield 1 1 Not IP Low  
## 41 Battlefield 4 1 Not IP Low  
## 42 Battlefield: Bad 1 Not IP Low  
## 43 Bayonetta 1 Not IP High  
## 44 Bayonetta 2 1 Not IP Medium

# Function to get top three most common values  
get\_top\_three <- function(x) {  
 as.data.frame(sort(table(x), decreasing = TRUE)[1:10])}  
  
# Analyze the characteristics of the top 5 games  
characteristics <- top\_5k\_games %>%  
 summarise(  
 average\_rating = mean(Rating),  
 average\_year = mean(year\_adj)  
 )  
  
# Get top three genres, publishers, developers, and consoles  
top\_three\_genres <- get\_top\_three(top\_5k\_games$genre)  
top\_three\_publishers <- get\_top\_three(top\_5k\_games$publisher)  
top\_three\_developers <- get\_top\_three(top\_5k\_games$developer)  
top\_three\_consoles <- get\_top\_three(top\_5k\_games$console)  
  
# Print results  
print(characteristics)

## average\_rating average\_year  
## 1 3.628571 14.47619

print("Top Three Genres:")

## [1] "Top Three Genres:"

print(top\_three\_genres)

## x Freq  
## 1 Action 6  
## 2 Shooter 5  
## 3 Adventure 3  
## 4 Action-Adventure 2  
## 5 Simulation 2  
## 6 Party 1  
## 7 Platform 1  
## 8 Role-Playing 1  
## 9 <NA> NA  
## 10 <NA> NA

print("Top Three Publishers:")

## [1] "Top Three Publishers:"

print(top\_three\_publishers)

## x Freq  
## 1 Electronic Arts 5  
## 2 Sega 4  
## 3 Unknown 3  
## 4 Nintendo 2  
## 5 Warner Bros. Interactive 2  
## 6 Focus Home Interactive 1  
## 7 Gears for Breakfast 1  
## 8 Level 5 1  
## 9 Telltale Games 1  
## 10 Warner Bros. Interactive Entertainment 1

print("Top Three Developers:")

## [1] "Top Three Developers:"

print(top\_three\_developers)

## x Freq  
## 1 EA DICE 2  
## 2 PlatinumGames 2  
## 3 Rocksteady Studios 2  
## 4 EA Digital Illusions CE 1  
## 5 From Software 1  
## 6 Gabe Cuzzillo 1  
## 7 Gears for Breakfast 1  
## 8 Hazelight 1  
## 9 Innersloth 1  
## 10 Millenium Kitchen 1

print("Top Three Consoles:")

## [1] "Top Three Consoles:"

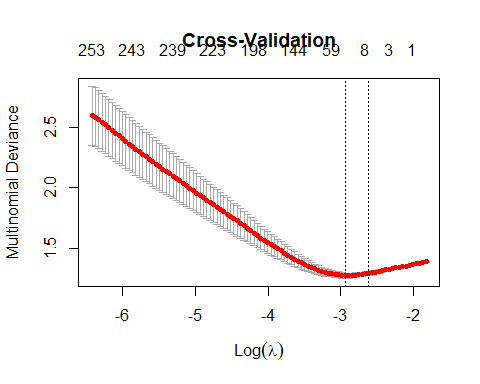
print(top\_three\_consoles)

## x Freq  
## 1 3DS 2  
## 2 PS4 XOne PC All 2  
## 3 All NS WiiU 1  
## 4 All PC OSX XOne PS4 1  
## 5 All PS4 NS PC 1  
## 6 NS 1  
## 7 NS PS4 PC XOne 1  
## 8 PC NS 1  
## 9 PS3 X360 PC 1  
## 10 PS3 X360 PC All 1

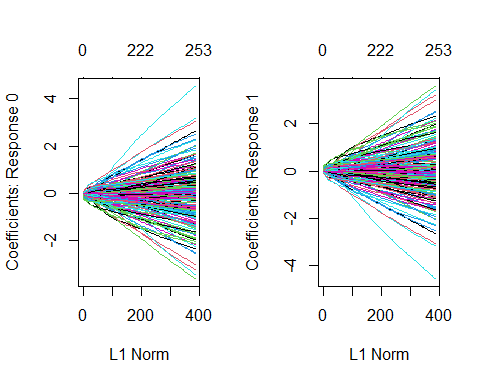
## Multinomial Logistic Regression

# Ensure response is a factor if it's multinomial  
# Split data for cross-validation  
set.seed(123)  
predictors\_knn <- cbind(year\_cont, genre\_dummies, rating\_cont, publisher\_dummies, developer\_dummies, ip\_dummies, tdm\_sparse, console\_sparse)  
predictors\_knn <- as(predictors\_knn, "sparseMatrix")  
quantiles <- quantile(game$activePlayers, probs=c(0, 0.5, 1), na.rm=TRUE)  
y <- cut(game$activePlayers, breaks=quantiles, include.lowest=TRUE, labels=c(0, 1))  
train\_indices <- createDataPartition(y, p = 0.5, list = TRUE)  
train\_data <- predictors\_knn[train\_indices[[1]], ]  
train\_response <- y[train\_indices[[1]]]  
test\_data <- predictors\_knn[-train\_indices[[1]], ]  
test\_response <- y[-train\_indices[[1]]]

set.seed(1234)  
  
# Fit the glmnet model  
cv\_fit <- cv.glmnet(train\_data, train\_response, family = "multinomial")  
plot(cv\_fit, main="Cross-Validation")



par(mfrow=c(1,2))  
plot(cv\_fit$glmnet)



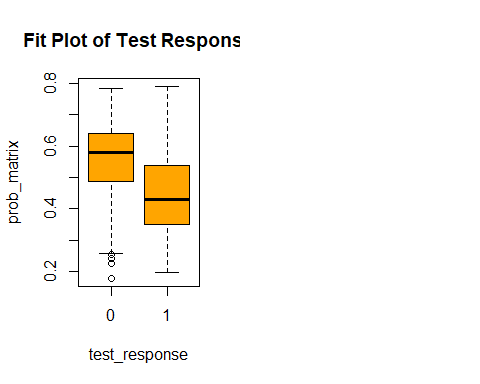
best\_coefs <- coef(cv\_fit, s = "lambda.min")  
coefs\_matrix <- as.matrix(best\_coefs)  
print(coefs\_matrix)

## [,1]   
## 0 <S4 class 'dgCMatrix' [package "Matrix"] with 6 slots>  
## 1 <S4 class 'dgCMatrix' [package "Matrix"] with 6 slots>

# Predict and evaluate model  
predictions <- predict(cv\_fit, newx = test\_data, s = "lambda.min", type = "response")  
predicted\_classes <- apply(predictions, 1, which.max)  
accuracy <- mean(predicted\_classes == test\_response)  
print(paste("Accuracy: ", accuracy))

## [1] "Accuracy: 0.169753086419753"

# Plotting class probabilities  
prob\_matrix <- predict(cv\_fit, newx = test\_data, type = "response", s = "lambda.min")  
boxplot(prob\_matrix ~ test\_response, col = "orange", varwidth = TRUE, main="Fit Plot of Test Response")

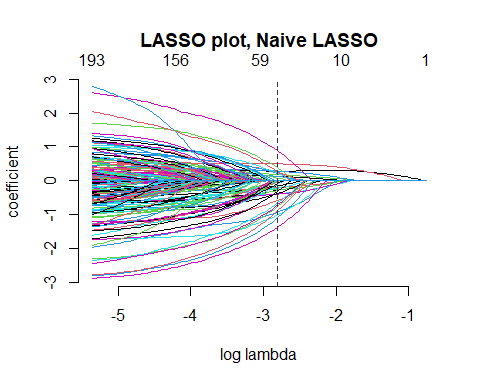


## Does higher rating causes more number of players?

library(gamlr)  
library(Matrix)  
library(dplyr)  
  
set.seed(1234)  
  
# Selecting columns and creating model matrix  
game\_console <- cbind(game[, c("year\_adj", "Number.of.Reviews", "publisher", "genre")], console\_df)  
game\_console$year\_adj <- scale(game\_console$year\_adj)  
game\_console$Number\_of\_Reviews <- scale(game\_console$Number.of.Reviews)  
game$genre <- as.factor(game$genre)  
game$publisher <- as.factor(game$publisher)  
game$Rating <- as.numeric(game$Rating)  
  
# Convert to a model matrix for Lasso  
x <- model.matrix(~ ., data = game\_console)  
d <- game$Rating # Treatment  
y <- game$log\_activePlayers # Outcome  
  
  
## NAIVE LASSO regression  
# Naive LASSO adds "treatment" as an extra covariate without giving it any special attention  
naive <- gamlr(cbind(d,x),y)  
coef(naive)["d",] # effect is AICc selected <0

## [1] 0.5007839

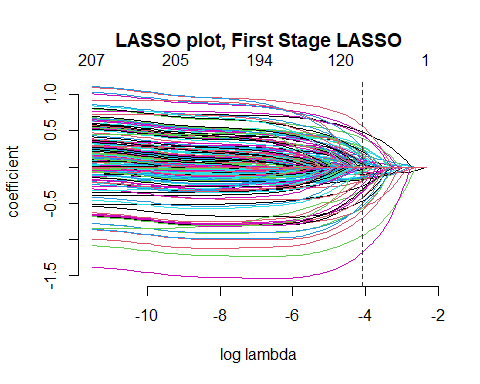
plot(naive, main = "LASSO plot, Naive LASSO")



coef(naive, select=which.min(AICc(naive)))

## 213 x 1 sparse Matrix of class "dgCMatrix"  
## seg45  
## intercept 9.79643521  
## d 0.50078392  
## (Intercept) .   
## year\_adj 0.28814010  
## Number.of.Reviews .   
## publisher2K Games 0.07668139  
## publisher3909 LLC .   
## publisher505 Games .   
## publisher5pb -0.09547845  
## publisher8-4 .   
## publisherActivision -0.28462827  
## publisherAksys Games .   
## publisherAmanita Design .   
## publisherAnnapurna Interactive .   
## publisherArc System Works .   
## publisherArena Entertainment .   
## publisherAtari -0.37564090  
## publisherAtlus .   
## publisherBandai Namco Entertainment .   
## publisherBedtime Digital Games .   
## publisherBerserk Games .   
## publisherBethesda Softworks .   
## publisherBinary Haze Interactive .   
## publisherBlizzard Entertainment .   
## publisherCapcom .   
## publisherCD Projekt .   
## publisherCD Projekt Red Studio -1.09518094  
## publisherCoffee Stain Publishing .   
## publisherCoffee Stain Studios .   
## publisherDECK13 Interactive GmbH .   
## publisherDeep Silver .   
## publisherDelightworks .   
## publisherDevolver Digital .   
## publisherDotEmu .   
## publisherDouble Fine Presents .   
## publisherDouble Fine Productions .   
## publisherDrinkBox Studios -0.65820969  
## publisherEA Sports -0.92600865  
## publisherEidos Interactive .   
## publisherElectronic Arts .   
## publisherEmber Lab .   
## publisherEndnight Games Ltd .   
## publisherFacepalm Games -0.09719942  
## publisherFinji .   
## publisherFocus Home Interactive .   
## publisherFrictional Games .   
## publisherFuncom .   
## publisherGalactic Cafe .   
## publisherGameMill Entertainment .   
## publisherGearbox Software 0.22100199  
## publisherGears for Breakfast .   
## publisherGR3 Project .   
## publisherGrinding Gear Games .   
## publisherGT Interactive .   
## publisherGun Media -0.31479862  
## publisherHi-Rez Studios .   
## publisherHumble Bundle .   
## publisherIgnition Entertainment .   
## publisherInti Creates .   
## publisherIO Interactive .   
## publisherJackbox Games -1.01076354  
## publisherJumpship .   
## publisherJupiter Corporation .   
## publisherKitfox Games .   
## publisherKonami .   
## publisherKonami Digital Entertainment .   
## publisherLevel 5 .   
## publisherLucasArts .   
## publisherMajesco .   
## publisherMarvelous .   
## publisherMatt Makes Games Inc. -0.89549868  
## publisherMedia.Vision -1.37663524  
## publisherMerge Games .   
## publisherMicrosoft Game Studios .   
## publisherMicrosoft Studios .   
## publishermiHoYo -0.31868649  
## publisherMTV Games .   
## publisherNamco .   
## publisherNamco Bandai .   
## publisherNamco Bandai Games .   
## publisherNdemic Creations .   
## publisherNicalis .   
## publisherNight School Studio .   
## publisherNintendo .   
## publisherNIS America .   
## publisherNumber None .   
## publisherPanic .   
## publisherParadox Interactive .   
## publisherPerfect World Entertainment .   
## publisherPillow Castle .   
## publisherPlaydead .   
## publisherPlaystack 0.37768442  
## publisherPlayStation PC .   
## publisherPolytron .   
## publisherPopCap Games .   
## publisherPrivate Division .   
## publisherRaw Fury .   
## publisherRebellion Developments .   
## publisherRebellion Games .   
## publisherRed Barrels .   
## publisherRed Hook Studios .   
## publisherRedOctane .   
## publisherRiot Games .   
## publisherRockstar Games .   
## publisherScott Cawthon .   
## publisherSega .   
## publisherSierra Entertainment .   
## publisherSloclap .   
## publisherSold Out .   
## publisherSony Computer Entertainment -0.21614530  
## publisherSony Computer Entertainment America .   
## publisherSony Interactive Entertainment .   
## publisherSony Online Entertainment -0.58262853  
## publisherSpike .   
## publisherSpike Chunsoft 0.28081313  
## publisherSpike Co. -0.08012095  
## publisherSquare-Enix .   
## publisherSquare Enix .   
## publisherStarbreeze Studios .   
## publisherSteel Crate Games .   
## publisherStudio MDHR -0.76432593  
## publisherSubset Games .   
## publisherSupergiant Games -0.07861757  
## publisherTake-Two Interactive .   
## publisherTeam 17 .   
## publisherTeam Cherry -0.71674496  
## publisherTeam Meat .   
## publisherTecmo 0.88350156  
## publisherTelltale Games .   
## publisherThe Behemoth .   
## publisherThe Indie Stone .   
## publisherThekla, Inc. .   
## publisherTHQ .   
## publisherThunder Lotus Games .   
## publisherTripwire Interactive .   
## publisherType-Moon .   
## publisherUbisoft .   
## publisherUnknown .   
## publisherValve 0.20474133  
## publisherValve Corporation .   
## publisherVivendi Games .   
## publisherWarner Bros. Interactive .   
## publisherWarner Bros. Interactive Entertainment -0.14630583  
## publisherWayForward .   
## publisherWayForward Technologies .   
## publisherWSS playground .   
## publisherWube Software LTD. .   
## publisherXbox Game Studios .   
## publisherXseed Games .   
## publisherYacht Club Games .   
## publisherYoung Horses -0.01440667  
## publisherZA/UM .   
## genreAction-Adventure .   
## genreAdventure .   
## genreFighting -0.39356923  
## genreMisc -0.38632880  
## genreMMO .   
## genreMusic .   
## genreParty .   
## genrePlatform 0.12488504  
## genrePuzzle -0.29276021  
## genreRacing .   
## genreRole-Playing 0.12937140  
## genreShooter .   
## genreSimulation .   
## genreSports .   
## genreStrategy .   
## genreVisual Novel .   
## All .   
## PS4 0.18375818  
## NS .   
## PC .   
## OSX .   
## XOne .   
## PS5 .   
## XS 0.28475046  
## Series .   
## X360 .   
## XBL .   
## PS3 .   
## Wii -0.20088846  
## `3DS` .   
## PSV .   
## PS2 .   
## PSN .   
## WiiU -0.25676248  
## Linux .   
## XB .   
## And .   
## WinP .   
## DS .   
## PSP .   
## GBA .   
## NES .   
## iOS .   
## SNES .   
## VC .   
## GC .   
## Ouya .   
## OR .   
## WW 0.24096180  
## GEN .   
## MS .   
## Arc .   
## GB .   
## GG .   
## SCD .   
## DSi .   
## DSiW .   
## Mob .   
## S32X .   
## PS .   
## Number\_of\_Reviews .

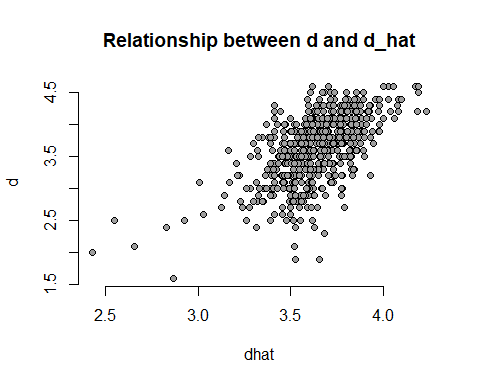
# this is the effect of treatment, given everything else that LASSO keeps in the model the "everything else", however, might not include all the confounders :(  
  
  
## Two stage LASSO  
# First stage Lasso to predict treatment  
treat <- gamlr(x, d, lambda.min.ratio=1e-4)  
plot(treat, main = "LASSO plot, First Stage LASSO") # Visualize the variable selection



# Predict the treatment (d\_hat)  
dhat <- predict(treat, x, type="response")  
cor(drop(dhat),d)^2

## [1] 0.3772716

plot(dhat,d,bty="n",pch=21,bg=8, main = "Relationship between d and d\_hat")



# Second stage Lasso to predict the outcome  
causal <- gamlr(cbind(d, dhat, x), y, free=2, lmr=1e-4)

## 'as(<dgeMatrix>, "dgCMatrix")' is deprecated.  
## Use 'as(., "CsparseMatrix")' instead.  
## See help("Deprecated") and help("Matrix-deprecated").

coef(causal)["d",] # Extract the coefficient for the treatment

## [1] 0.3954586

n <- nrow(x)  
gamma <- c() # Initialize storage for bootstrap results  
  
for(b in 1:100){  
 ib <- sample(1:n, n, replace=TRUE)  
 xb <- x[ib, ]  
 db <- d[ib]  
 yb <- y[ib]  
 treatb <- gamlr(xb, db, lambda.min.ratio=1e-3)  
 dhatb <- predict(treatb, xb, type="response")  
 fitb <- gamlr(cbind(db, dhatb, xb), yb, free=2)  
 gamma <- c(gamma, coef(fitb)["db", ])  
}  
  
summary(gamma) # Summarize the bootstrap results

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 0.1111 0.3687 0.4348 0.4291 0.5127 0.6520

mle <- glm(y ~ cbind(d, x))   
  
# # get a standard error from Bootstrap  
#  
mean(gamma)+2\*sd(gamma)

## [1] 0.6520635

mean(gamma)-2\*sd(gamma)

## [1] 0.2061821

se <- summary(mle)$coef[2, 2]  
se

## [1] 0.1151139

sd(gamma)

## [1] 0.1114704

# Plot Boostrap  
hist(gamma, freq = FALSE, main = "Bootstrapping Result, Causal Effect of Rating (gamma)", xlim = c(0, 0.1))  
  
# Calculate the standard error and coefficient from your model mle  
  
coef\_estimate <- coef(mle)["cbind(d, x)d"]  
  
# Add vertical lines  
abline(v = coef\_estimate, col = "orange", lwd = 2) # Original estimate  
text(coef\_estimate, 0, labels = "mle Est.", pos = 3, cex = 0.8, col = "orange")  
abline(v = mean(gamma), col = "purple", lwd = 2) # gamma mean  
text(mean(gamma), 0, labels = "Boostrap Est.", pos = 3, cex = 0.8, col = "purple")  
  
# Confidence interval from mle  
abline(v = coef\_estimate + 2 \* se, col = "orange", lwd = 2, lty = "dashed") # Upper mle CI  
text(coef\_estimate + 2 \* se, 0, labels = "mle CI", pos = 3, cex = 0.8, col = "orange")  
abline(v = coef\_estimate - 2 \* se, col = "orange", lwd = 2, lty = "dashed") # Lower mle CI  
text(coef\_estimate - 2 \* se, 0, labels = "mle CI", pos = 3, cex = 0.8, col = "orange")  
  
# Confidence interval from bootstrap  
abline(v = quantile(gamma, 0.025), col = "purple", lwd = 2, lty = "dashed")  
text(quantile(gamma, 0.025), 0, labels = "Bootstrap CI", pos = 3, cex = 0.8, col = "purple")  
abline(v = quantile(gamma, 0.975), col = "purple", lwd = 2, lty = "dashed")  
text(quantile(gamma, 0.975), 0, labels = "Bootstrap CI", pos = 3, cex = 0.8, col = "purple")

